THE
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THE ATOMIC THEORY.

PROF. RÜCKER, in his able presidential address, delivered to the British Association at Glasgow on Wednesday, devoted himself to a defence of the atomic theory, which he selected as representing the fundamental conceptions of the physical sciences. A president of the British Association could have set himself no more appropriate task at the close of a century which practically included the whole of the marvellous growth of modern physics. The defence had also become necessary on account of the powerful attacks on scientific beliefs by certain writers in the metaphysical camp, such as Dr. Ward, in his work on "Naturalism and Agnosticism." Prof. Rücker's defence is common sense and convincing to the plain man, and the physical or chemical investigator, after reading and digesting it, will still continue to make use of the atomic theory to explain his observations, free from any uneasy suspicions he may have had that he might be altogether on the wrong tack. Prof. Rücker is not content with the highly abstract formulæ which satisfy the minds of the mathematical physicists, he must have a concrete model of Nature. The atomic theory, as he takes it, simply amounts to a statement that matter in its ultimate constitution is not continuous, but "coarse grained." Sir Roberts Austen's remarkable experiments on the diffusion of gold into lead, at ordinary temperatures, are cited as supporting the "coarse grained" view. Little is said in the address about the constitution of the granules which form the basis of matter, though it is admitted that as the range of the atomic theory is extended, the fundamental conception must be filled in by supplementary hypotheses as to the constitution of the granules. Another proof of the existence of "granules" in matter, cited by Prof. Rücker, is the remarkable series of experiments of Mr. C. T. R. Wilson and Prof. J. J. Thomson. These scientists have shown that under certain circumstances a free ion acts as a nucleus for the condensation of moisture, "so that each became a water drop, till the host of invisible molecules was, as it were, magnified by accretion into a visible mist." The discovery by Prof. J. J. Thomson that the atoms themselves can be broken up into corpuscles or electrons, is interpreted by Prof. Rücker to mean that "matter of all kinds will some day be proved to be fundamentally the same." Dealing with the question as to whether the atomic theory is a unique explanation of material phenomena, the President says that "The atomic theory must hold the field until another can be found which is not inferior as an explanation of the fundamental difficulties as to the constitution of matter, and is, at the same time, not less comprehensive." Prof. Rücker's views as to the nature of living matter are somewhat vague, but his sympathies may be inferred from his statement that "physiology has specially flourished since physiologists have believed that it is possible to master the

definite fraction of the main current passes through the cell.

massage apparatus. 1 claim.

physics and chemistry of the framework of living things, and since they have abandoned the attitude of those who placed in the foreground the doctrine of vital force." The final conclusion of the learned President is "that atoms are not merely helps to puzzled mathematicians but physical realities."

High Speed Railways.

On another page we give an abstract of Herr Lasche's paper on the high speed car built by the Allgemeine Company. In the paper itself very full details are given of the construction, and it is intended to make exhaustive trials of the car to elucidate facts. The car is assumed to be capable of a speed of 124 miles per hour, though it is possible that higher speeds may be attempted should the car prove fit and capable. High tension current is at present intended, with transformers on the car, an expedient which is admittedly open to criticism. This car appears to be a genuine attempt to solve the high speed question on conservative lines; but we cannot think that the carrying of the transformers on the car is altogether good, though it may cheapen general construction. A four-motor equipment is employed, but there are six axles. The motors are spring coupled, so as to avoid the trouble of uncushioned weight. The liquid resistance seems well arranged to prevent trouble from careless driving, as it automatically varies in accordance with the speed in a most ingenious manner. The spring coupling is a kind of three-ray star of laminated springs bearing against abutments on the wheels, and provided with swivel abutment struts. We should like to see this coupling a success. It is scarcely necessary to point out that any car intended to carry 3,000 H.P. of motors on four axles, to run at an average of 1,100 H.P., must involve many difficulties. We hope to see that less than 1,100 H.P. will run such a car as described. It seems a lot of power for 50 passengers when compared with 1,000 H.P. indicated that is said to be about the power of a passenger steam locomotive with a fair train at high speed. So far the car has been tested on friction wheels only. The paper is of the highest interest, and should afford useful hints to designers of high speed cars.

The Rating of Electrical Machinery.

The paper read by Mr. Gisbert Kapp at Glasgow last week, which we reproduce in full in this issue, deals with a subject of the first importance to the British electrical industry. The rating of electrical machinery—especially of dynamos and motors—has for long been a sore point with us; for whereas some foreign manufacturers lay stress on the output of their machines for short periods, our custom has always been to specify the load which our machines will carry night and day. The natural consequence has been that many an order has gone abroad, which would have remained in this country if a fair basis of comparison had been employed; the British dynamo, under such conditions, is bound to cost far more than its foreign competitor, and the fact that the latter, if worked continuously at its nominal load, will get red hot, is only discovered when it is too late.

The steps which the German Association has taken to put an end to this unfair system of rating, as set forth in the appendix to Mr. Kapp's paper, are to be most heartily commended, and our own Institution would be well advised in following the good example now before it.

A Novel Trolley-Wire Protector.—An engineer in the provinces, having been behindhand with his invention for preventing "Liverpool" accidents when that great scare pulled the trigger for such a multitude of guards to be shot on to the market, has taken the happy occasion of Prof. Jamieson's Glasgow paper to present his scheme for inspection on paper. In an article in the last number of the Electrical Review it was remarked that, while overhead telegraph and telephone wires existed, the only absolutely safe way to protect the public would be to build a roof over the trolley wires.

The engineer of whom we write must be congratulated on having either forestalled us with this idea, or upon acting on the suggestion with wonderful celerity; but we think that he has not made the most of his opportunity. He suspends over the trolley wire, by means of various guy wires and straining devices, an inverted trough made of $\frac{1}{8}$ in. galvanised sheeting "profusely ornamented" with holes, which bring the weight of the trough alone down to the insignificant amount of 200 lbs. per span. Over two wires which are not too far apart is suspended—on paper—a flat-topped trough. Now, we had in our mind a rather more substantial affair, and one which might be made to serve a variety of purposes other than the original. *We* should erect, on stout steel columns placed at convenient intervals in the roadway, buckled plates supported on **I** joists and filled in as to the top with cement. In the case of a single line this protector would be sufficiently broad to cover a tram, thus keeping the rain off the top deck passengers. With a double line we should be inclined to extend the "protector" over the whole roadway, and perhaps the pavements as well; in fact, we think that, directly this suggestion is made known, all local authorities will compel intruding tramway companies to adopt this "protector" throughout their areas. When we think of the royalties that would accrue, we regret that we are not writing a patent specification, instead of a "Note" in a technical paper. Not only would our protector be of service in guarding the travelling public from the excursions of the electric, and the damper and less "subtle fluid"; it would form, moreover, a most convenient promenade for citizens interested in astronomy and the home life of frontagers, and portions might be converted into hanging gardens and shooting galleries. We anticipate, indeed, that if the supports were made of sufficient strength, an elevated railway might be run on it with advantage. The street columns would be found most useful for obstacle races in municipal bicycle gymkhanas, and driving tests for motor car men.

We are extremely sorry to say that the constant thought required to work out this "protector" has so engrossed our time that none has been left for the making of drawings. When these are made, however, we shall follow the above-mentioned engineer in the endeavour to obtain a beautiful effect, without regard to the accuracy of details.

Finsen Light.—Mr. J. H. Buxton, presiding at a meeting of the governors of the London Hospital last week, said that the Finsen light treatment of lupus, which was introduced into the hospital by the Queen, continued to be a great success. The lamps had been of the utmost service, but it had been discovered that smaller and cheaper ones were equally effective. During the past 15 months 215 patients had been treated.

At the half-yearly board meeting of the Governors of the Bristol General Hospital on Monday, it was mentioned that Sir William Henry Wills had authorised the institution to draw on him up to £600 for the provision of the Finsen ray apparatus for the treatment of lupus. The hospital has already been provided with an X ray equipment.

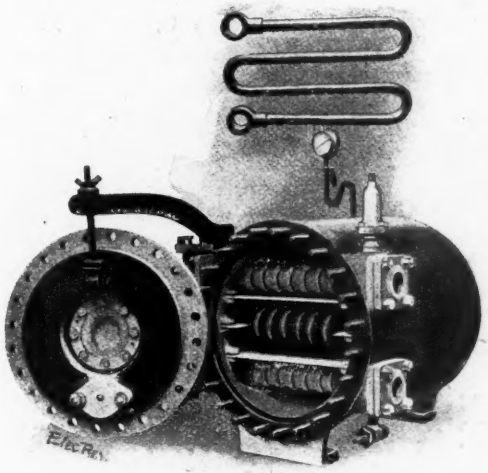
Nernst Lamps.—On September 4th, at 7 p.m., at the stand of the Electrical Company, Limited, in the Glasgow Exhibition, there was on view an assortment of Nernst lamps made by the A.E.G. Lord Kelvin was present, and after inspecting the mechanism of the lamps, he switched on for public view a row of 12 Nernst lamps arranged above the stand. About a minute after switching on the lamps gave a brilliant light. This is the first public appearance in Scotland of the new lamps. They will do service at the stand until the close of the Exhibition.

GLASGOW INTERNATIONAL EXHIBITION, 1901.

IX.

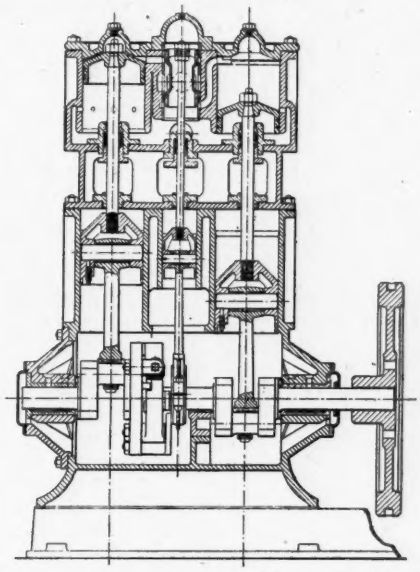
MESSRS. ALLEY & MACLELLAN.

Besides other machinery of a general description, Messrs. Alley & MacLellan, of the Sentinel Works, Glasgow, show an aggregate output of about 600 H.P. of their "Sentinel" high speed engines. Of these there is one of 300 I.H.P. on loan to the Exhibition, supplying part of the power used in the lighting and power distribution of the Exhibition. This has already been described and illustrated in our article on the power department.

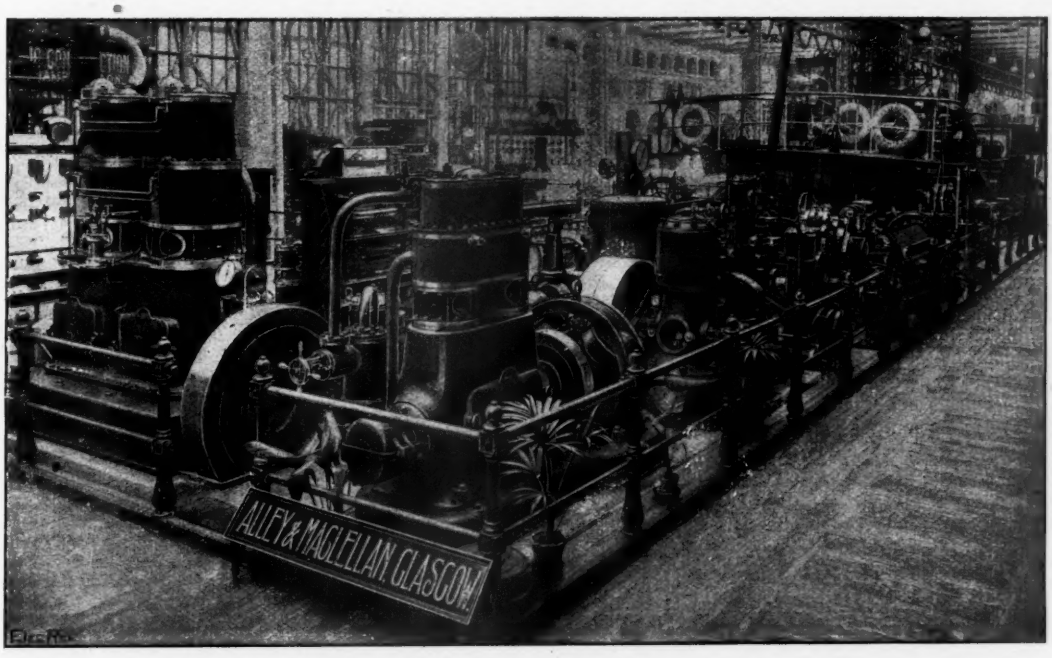


FEED WATER HEATER, OPEN.

"H" type, which is adopted for the smaller sizes up to 150 B.H.P., is shown running; it is coupled to a Laurence-Scott four-pole dynamo, giving 170 amperes at 225 volts, 500 revolutions per minute, both being mounted on a combined bedplate. This engine has two cranks and two pairs of tandem cylinders, these being 6 in. and 10 in. diameter × 6 in. stroke; the speed is 525 revolutions per minute, and the output at 150 lbs. pressure 50 B.H.P. In this type of engine there is only one line of valves, which is placed between the two lines of cylinders, and driven by a single eccentric. Lubrication and governing are effected in the same way as in the larger engine. The overall efficiency of the set is 85 per cent. at full load.



SECTION OF "MARINE AUXILIARY," CONDENSING ENGINE.



MESSRS. ALLEY & MACLELLAN'S STAND.

On their own stand, which adjoins the power station, is shown an engine of 200 I.H.P., with cylinders 11 and 18 in. × 9 in., being a duplicate of the 300-I.H.P. engine just mentioned, with the exception that it has only two lines of parts, and the cranks are set diametrically opposite; each line of parts, however, is an exact duplicate of each line of parts in the three-crank engine. Another engine, of their

Besides these there are two of the Sentinel marine auxiliary simple condensing engines, one direct coupled to a 6-KW. dynamo, running at 550 revolutions per minute, to supply the electric light for the stand, and the other of 5 B.H.P. driving direct a centrifugal pump, also of the firm's own make.

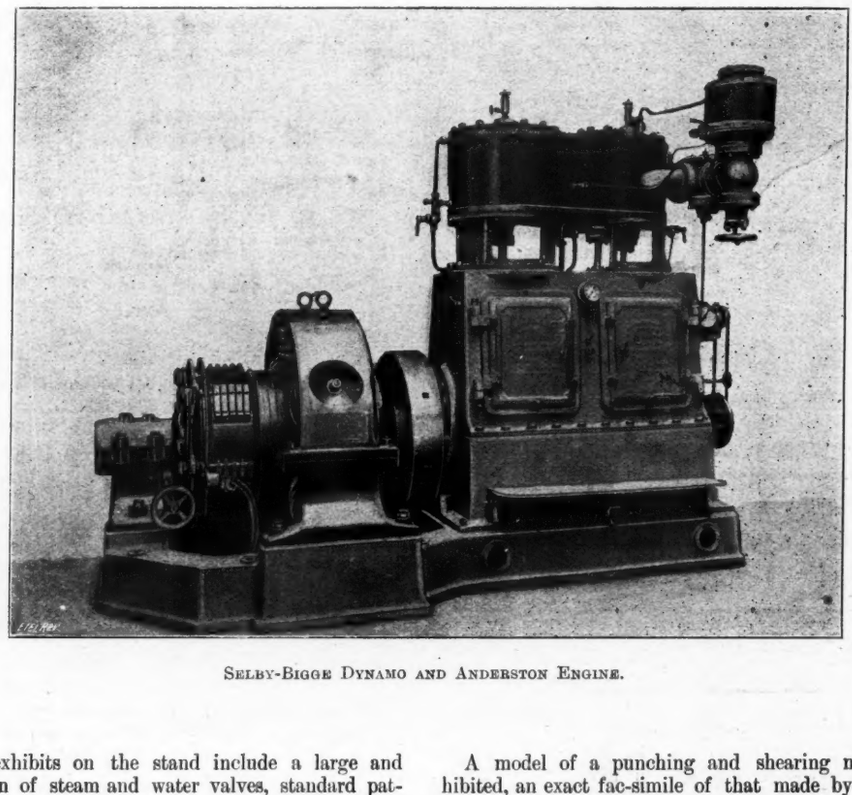
D

In these engines the air cylinder is separate, shortening the engine, but increasing the length of the connecting rod. A shaft governor is used, which rotates an eccentric pulley. Both cylinders of the larger engine are 5½ in. in diameter, with 4 in. stroke, and the B.H.P. is 10 non-condensing, 11 condensing, at the normal speed of 600 revolutions per minute.

The smaller engine is of similar design, and runs at 650 revolutions per minute. These engines are very simple and cheap; one of them has run for 16 years, costing only £3 for repairs, and a larger one ran night and day for 12 years, costing £5 for repairs.

E.H.P. steam dynamo. The engine is made by the Anderston Foundry Company, and is of the compound, high speed, balanced, forced lubrication type, which has been largely used by this firm. It is on one bedplate with the multipolar continuous current generator, to which it is coupled direct. The engine is completely enclosed, but the main casing is fitted with four large hinged doors, giving ready access to the interior. The accompanying photograph illustrates the plant.

The company also exhibit a 25-H.P. motor driving a winch with worm and worm wheel, which work in an oil bath, and thus reduce frictional losses to a minimum.



Selby-Bigge Dynamo and Anderston Engine.

The other exhibits on the stand include a large and varied collection of steam and water valves, standard patterns of horizontal and vertical steam-steering gears, steam-warping capstans, ash hoists, feed-water filters, feed-water heaters (Binny's patent), and air compressors and hoists. A ship's deckhouse and bridge are fitted up at one end of the stand, giving it a very nice finish and attractive appearance.

In one of the feed-water heaters, made to W. M. Binny's patent, the steam circulates through copper bends, with four limbs consisting of six copper tubes in parallel, and the water outside, guided by baffle plates. The design of this heater is highly ingenious, and it is arranged so that one man can easily carry out all repairs without assistance. Careful tests made at the works show a total efficiency (total heat to water + heat to hot well, ÷ total heat of steam) of over 98 per cent. The overall dimensions, to deal with 1,000 gallons of water per hour, are about 3 ft. cube.

A feed-water filter of interesting design is shown; the mantles are slipped over six perforated tubes carried on a rotating carrier, and can be replaced one by one without opening a hole larger than 5 in. in diameter in the cover. About 250 sq. ft. of three-ply matting are required.

A highly efficient compound air compressor is also exhibited.

Messrs. D. Selby Bigge & Co.

Messrs. D. Selby Bigge & Co., of Newcastle-on-Tyne, have, for the last 10 years, made a speciality of electric power work, and have carried out about 80 installations, of different sizes, including 20 shipyards, in some of which there is no steam plant, other than that for driving the main generators.

Their exhibit at Glasgow Exhibition consists of a 200-

A model of a punching and shearing machine is exhibited, an exact fac-simile of that made by Messrs. Craig and Donald, to ⅛ scale. This model can be seen working, driven by a small motor, attached to the top of the machine.

The switchboard, at the back of the stall, forms a suitable background, and is a good example of the design adopted by this company in their power installations; the panels are of enamelled slate, and are fitted with knife switches in front, while the fuses are all fixed on the back of the board.

A GRAPHIC PROOF OF THE BETTS TEST.

By E. RAYMOND-BARKER.

The article entitled "A New Method of Localising a Fault in a Single Cable" in the Electrical Review, of August 16th, 1901, affords matter of practical interest to the cable student, at whose disposition Mr Walter Betts has placed figures obtained in actual practice on a long submarine cable—figures which constitute a welcome addition to the cable electrician's note book.

In the Betts method, equal batteries, zinc to line, are simultaneously applied, through suitable galvanometers, to the two ends of the cable in which a fault has to be localised. The two galvanometers need not have similar figures of merit. At set times synchronous readings are noted at both testing stations, A and B, and, by comparison with a galvanometer constant obtained through a standard resistance,

are worked out into corresponding resistance values. The resistances thus obtained at the two ends of the line are respectively termed a and b. Although these resistances vary according to changes at the fault, each simultaneous pair a and b are strictly comparable.

Then, if L be C R of line when perfect,

$$\text{Distance } x \text{ of fault from A} = \text{L}\,\frac{a}{a+b} \text{ ohms.}$$

$$\text{" " " " B} = \text{L}\,\frac{b}{a+b} \text{ "}$$

In each case resistances of shunted galvanometer, battery, earth, &c., must, of course, be deducted from the result.

An interesting feature of Mr. Betts's test, as shown in his fig. 1, is its striking adaptability to graphic illustration, as will be shown in the present note.

If only to afford further illustration of the French dictum "Les beaux esprits se rencontrent," the writer ventures to point out that the development shown by Mr. Betts of his test in his fig. 2 constitutes an electrical condition of things similar in all respects to that present in M. Henri Wilbrant's test referred to by the writer in his "note" on this and kindred tests published in the ELECTRICAL REVIEW of November 21st, 1890. In the note in question the writer showed how Wilbrant's test was a development of May's method, in which the polarisation current from a fault is utilised for localisation by being made to actuate galvanometers at the two ends of a line to give deflections inversely proportional to the two respective branch resistances traversed by the fault current. The writer also pointed out how all these tests might be simplified by the addition of artificial resistance by the station nearer to the fault, sufficient to equalise the deflection values. Regarding May's utilisation of E.C. potential, the Ansell-Young method of strongly polarising a fault in order to generate a secondary fault E.M.F. for testing purposes will recur to many.

Mr. Walter Betts certainly justifies his opinion that equalisation of deflection values by artificial centralisation of the fault is unnecessary, and is productive of the loss of the time gained when absolutely synchronous pairs of readings are noted at the two terminals of a cable, and the two equivalent resistances are calculated from a constant by the ordinary comparison of deflection method and a standard resistance.

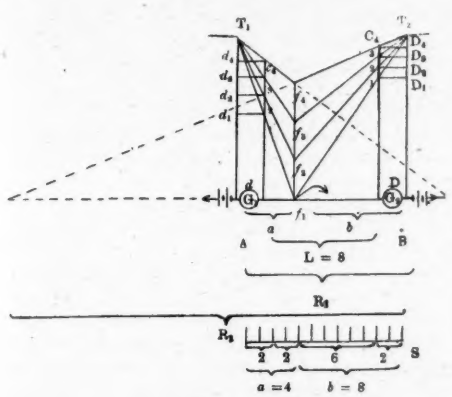


FIG. 1.

Fig. 1 affords a graphic illustration of the Betts test, and shows at a glance that deflections d and D on G_1 and G_2 at stations A and B are respectively inversely proportional to the resistances a and b, also to the *apparent* resistances R_1 and R_2 due—as Mr. Betts points out—to the mutual opposition of the currents from the two cable ends at which P.Ds. are respectively the perpendiculars T_1 and T_2.

Fig. 1 shows a simple case where the resistance of each of the galvanometers G_1 and G_2 at stations A and B is equal to that of one quarter the length of a cable conductor bisected by the fault in the relative proportion of 1 to 3. Four different conditions at the fault are shown, viz:—

f_1 Fault making dead earth.
f_2 " with resistance to earth giving potential $f_1 f_2$.
f_3 " " " " $f_1 f_3$.
f_4 " " " " $f_1 f_4$.

The following table summarises accompanying conditions:

Ex.	P.D. at fault.	Right angle triangle representing deflection on G_1	Right angle triangle representing deflection on G_2	Inverse proportions relative to deflections and actual resistances, *i.e.*, deflections inversely proportional to resistances. (Resistances) (Deflections) (Ratio)
1	*nil*	$T_1 d_1 c_1$	$T_2 D_1 C_1$	$b : a :: T_1 d_1 : T_2 D_1 = 2 : 1$
2	$f_1 f_2$	$T_1 d_2 c_2$	$T_2 D_2 C_2$	$b : a :: T_1 d_2 : T_2 D_2 = 2 : 1$
3	$f_1 f_3$	$T_1 d_3 c_3$	$T_2 D_3 C_3$	$b : a :: T_1 d_3 : T_2 D_3 = 2 : 1$
4	$f_1 f_4$	$T_1 d_4 c_4$	$T_2 D_4 C_4$	$b : a :: T_1 d_4 : T_2 D_4 = 2 : 1$

The *apparent* resistances when P. D. at fault is $f_1 f_4$ are shown in the diagram, viz., R_1 and R_2, and here again the inverse proportion obtains, viz:—

$$R_2 : R_1 :: T_1 d_4 : T_2 D_4 :: 2 : 1.$$

To avoid further elaboration of a diagram which for publication must necessarily be on a small scale, the *apparent* resistances acoompanying the other three conditions are not indicated, but they may readily be obtained by continuing to the common resistance base the lines $T_1 - f_3\, f_2\, f_1$ and $T_2 - f_3\, f_2\, f_1$.

Example: Let galvanometer deflections at stations A and B be respectively d and D.

Resistance represented by deflection $d = a$.
" " " " D $= b$.

Here the currents represented by deflections d and D are inversely proportional to the resistances traversed.

Let x = distance in ohms from A to fault, distance from B to fault thus becoming $L - x$.

Then

$$d : D :: L - x + G_2 : x + G_1.$$

Substituting in this expression the resistances a and b for the corresponding deflections d and D,

$$b : a :: L - x + G_2 : x + G_1,$$
$$b(x + G_1) = a(L - x + G_2),$$
$$bx + b G_1 = aL - ax + a G_2,$$
$$bx + ax = aL + a G_2 - b G_1,$$
$$x(a + b) = a(L + G_2) - b G_1,$$
$$x = \frac{a(L + G_2) - b G_1}{a + b}.$$

In like manner if x = ohms from B to fault, we have

$$a : b :: L - x + G_1 : x + G_2,$$

whence

$$x = \frac{b(L + G_1) - a G_2}{a + b}.$$

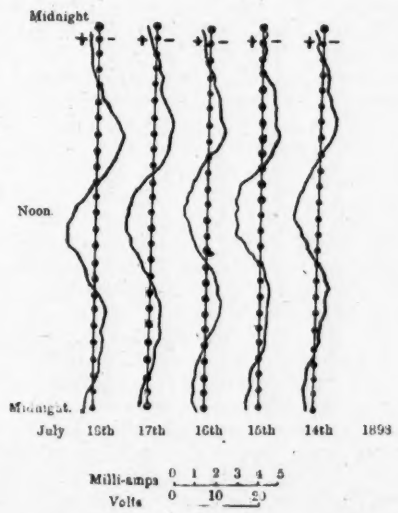


FIG. 2.

Scale S in fig. 1 shows the relative graphic resistance values given in the diagram, viz.:—

$G_1 = 2$ ohms. $a = 4$ ohms.
$G_2 = 2$ " $b = 8$ "
$L = 8$ ohms.

Their exhibit at Glasgow Exhibition consists of a 200-

nometer constant obtained through a standard resistance,

Applying formulæ :—

$$\text{Distance } x \text{ of fault from A} = \frac{4(8+2)-(8\times 2)}{4+8} = 2 \text{ ohms.}$$

$$\text{,, ,, ,, ,, B} = \frac{8(8+2)-(4\times 2)}{4+8} = 6 \text{ ,,}$$

$$6 + 2 = 8 \text{ ohms} = \text{L.}$$

In practice G_1 and G_2 at the respective stations would include resistance of shunted galvanometer + internal resistance of battery + any other resistance extraneous to the cable.

Although earth current complications may generally be brought within the scope of a little extra calculation, or of simple cable zero devices, much needless trouble may be avoided by tests being made at an hour when E.C. = *nil*, or approximately so. Under normal conditions prevailing over the Atlantic cables this *nil* condition occurs four times in the 24 hours, as may be seen from the curves shown in fig. 2, obtained by the writer on 1,600 N.M. of cable laid west-east, and earthed at both ends. *

THE DESIGN OF SWITCH GEAR.

By W. E. WARRILOW.

(Concluded from page 382.)

Low-pressure Gears.

Continuous-current switch gears controlling low pressures, and carrying heavy currents, are quite as important in the matter of efficient design as high-pressure boards, though many engineers think that a few slate panels, with instruments, &c., on the front, and connecting cables at the rear, are the essentials of a good gear. Viewed from a certain standpoint, say, that of first cost, this may be correct, but when examined on other grounds than those of economy, an entirely different opinion may be formed.

Take the connections first; these are usually brought along a trench from the various machines, and taken as seems convenient to the back of the board, where they are straggled in a hopeless manner to the particular socket they should enter.

Beyond a certain point discrimination is an impossibility, while the liability of the cables to become damaged is very great. The number of joints also which are made at the rear of the board introduces many points of weakness in the system, besides adding still further to the complication. Where cables are used as bus bars, the system is further weakened by a number of joints, which may fail at any awkward moment and cause failure of the supply. With large cables also there are great difficulties experienced in forming a suitable connection between the instrument or switch and the cable itself, sweating sockets beyond a certain size being very clumsy. The heavy currents to be carried make it essential that good contacts are everywhere assured ; if heating does occur at a faulty connection the probabilities are that a wholesale fire will ensue.

Cable connections on the board itself are far from satisfactory as a means of coupling the various fittings, while bus bars at the rear are scarcely more reliable, though they are certainly better than cables. Where heavy currents are dealt with it is of vital importance that connections between the various fittings on the gear should be made with a bare conductor, so that the possibility of fire may be reduced to a minimum.

Now, although there have not been as many accidents with direct current gears as with alternating, the fact remains unaltered that the average low pressure board is not a satisfactory article. The engineer in a continuous current station is perhaps well pleased with his board and has little or no trouble with it, nevertheless his particular instance may not be taken as a standard for all such classes of gear. Now that the pressure of supply has been raised, and it has become a common practice to supply lighting and traction from one station, there is increasing need for radical alterations in the design of direct-current gears. There can be no doubt that progress on the present lines has distinct limits, which are not far ahead, a circumstance which should call electrical engineers to a sense of the responsibilities resting with them as the representatives of a great industry. It is a fact which needs still to be recognised that the arrangement of switch gears cannot be much longer undertaken on the lines of pioneer concerns, whose output was small and conditions of supply limited. A considerable time elapsed before engineers would encourage the introduction of large units, in the mistaken policy that a number of small plants were more economical, and a similar stage in the development of direct-current switch gears seems to be now evident. The old design will do, because it does its work and is cheap, is the cry, in spite of the obvious maze of connections at the rear of the board, and the consequent liability of failure of the supply. Such economy, however, is already proving itself false, and a similar lesson is being taught with direct-current gears as has been with high pressure alternating.

Improved designs can now be laid down which will ensure a satisfactory and reliable arrangement without undue complication, while ease of manipulation is increased accordingly.

With heavy currents at comparatively low pressure the chief difficulty is experienced with mechanical joints in the circuits, to obtain good contact, and avoid heating. All apparatus carrying current must be designed with ample surface, without approaching clumsiness or sacrificing one advantage for another. With switches and fuses this is especially necessary, and when very heavy currents are dealt with the difficulties of design increase in proportion, though they do not necessarily tax the powers of the designer in overcoming them. In many classes of gear the cables have presented the greatest difficulties. The ordinary sweating socket has proved itself superior to other types of connection, though with large conductors exceptional care must be taken to ensure good contact. Boards with rear connections give the most trouble, as a neat disposition of large cables in a small space, where many couplings have to be made, has not been accomplished with anything approaching success.

The general arrangement of L.P. switchboards has been carried out on similar lines in most types. The connections of the positive side of the system occupy one side of the board, the negative connections the opposite side, while the centre is taken up with the middle wire, balancing and accumulator arrangements. Such a disposition of the switching apparatus is least liable to cause errors on the part of attendants. This class of gear has been adopted in all parts of this and other countries, but although it has given a certain amount of satisfaction, it does not represent the ideal of direct-current switch gear design.

The chief reason for this is the connections at the back of the board, and the lesson taught by high pressure gears having rear connections is now coming home to direct-current engineers. Compared with the couplings of a single-phase board, those of a direct-current gear are more complicated, consequently their neat arrangement at the back of the switch gear can be imagined to be no easy matter. This and other items have brought, and will bring, more to the front the direct-current gear without a back or any rear connections whatever.

There can be no gainsaying the statement that a switch gear carrying currents for public supply purposes should have no rear connections at all.

It was at first thought that the couplings of a direct current gear could not be arranged on the front of the wall, but it has been accomplished by at least one firm of electrical engineers in a satisfactory manner. This class of gear is well suited to a neat and compact arrangement of lighting and traction boards in one, without unduly complicating the connection. A board of the cell type lends itself more readily to neat couplings than does the gear with rear cable connections, as the various apparatus in the circuit can be formed in neat castings in such a way that each fits into its neighbour without introducing any other conductor into the circuit, such as cable or rod. The insulation of the board is less difficult to maintain, as all conductors are mounted

* "Atlantic Earth Currents," by E. Raymond-Barker, the Electrical Review, June 9th, 1899.

in porcelain, affording ample surface, while all parts likely to become damp or dirty can be cleaned with a minimum of trouble and danger.

In conclusion, the growing importance of electric supply demands that the attention of engineers be devoted more closely to the design of switch gears, as a type of apparatus which will always be necessary to the efficient distribution of power and light. The steam engine will not always be with us, and there are distinct limits to its development, so that, although special care is taken to obtain this section of electric generation as perfect as possible, the switchboard must not be sacrificed to it in any way. The value of the controlling apparatus in a station has been under-estimated considerably up to within the last year or two, and the sooner engineers can raise its status to a higher lever the better will it be for the industry; because the switch gear can be more easily standardised than any other portion of the station, a consideration which takes first place in the matter of importance.

REVIEWS.

The Economic Disposal of Towns' Refuse. By W. Francis Goodrich, A.I.Mech.E. London: P. S. King & Son.

This bulky volume, containing over 300 pages of closely-printed matter, is crammed from cover to cover with information respecting that much-discussed and hotly-debated apparatus, the refuse destructor. The author is an expert connected with one of the well-known firms of destructor builders.

Unquestionably the book appeals chiefly to those engaged in the trade and to borough surveyors and borough electrical engineers. It is a mine of information, not always arranged in the best order, but accessible by digging for it in the index. The book is copiously illustrated, and only has to be held upside down for the illustration on page 281, which is a little puzzling with the book in its ordinary position.

The first chapter on the evolution of the refuse destructor is a very brief, pithy and excellent *résumé* of early destructor history, upon which it would certainly be unwise to spend too much time. There is, however, one remark in it to which we must take exception, to the effect that in some instances the temperatures of the combustion chamber have reached 2,800° F. We should like to know what pyrometer was used for this test, as our experience is that 2,000° F. is a temperature very seldom reached in reality.

The author treats fully of refuse tipping, and pillories a large number of towns in which this process has been condemned. He also mentions the cases in which such condemnation has been followed by the ordering of a destructor.

Refuse sorting and utilisation systems are described; and there is also a chapter on the law relating to collection and removal of refuse.

Chapter 5 is one to which electrical engineers will turn with some interest, as it deals with the value of towns' refuse for steam raising, when judged from an analysis of the material.

The next chapter demonstrates the advantage of rapid combustion over slow combustion, and gives a list of destructors with quantities dealt with per cell for 24 hours. Unfortunately this table does not give the amount of labour required in each instance. This would have been a very interesting addition. There can be no doubt that such immense quantities burned as, for instance, 103 lbs. per square foot of grate per hour, mentioned as obtained at St. Helens, are only got at an enormous cost for labour. From 30 to 40 lbs. of refuse per square foot of grate per hour is a more reasonable rate of working.

The efficiency of various types of steam boilers is next discussed, but unfortunately without sufficient information being given, the different types of boiler at various installations being compared without reference to the proportion of heating surface provided to the amount of refuse dealt with; while at the same time the results are stated as so many pounds of steam per pound of refuse. The Lancashire boiler is favourably considered, but its greatest advantage in its capacity for storing power, to meet the peak of the lighting-load diagram, is not dwelt upon.

The Shoreditch installation comes in for severe criticism in connection with the arrangement of the boilers and cells alternately, and the burning of coal under the boilers, while at the same time they are being gas fired. It is rightly pointed out that a sacrifice in the coal burning efficiency under such conditions is inevitable. Incidentally in this chapter the use of skilled labour at destructors is strongly advocated.

Under the head of "External Deposit" upon boilers, a most extraordinary statement is made, to which we must take the very strongest exception. Mr. Goodrich says (page 53), "Therefore it is always advisable with power destructors, if at all possible, not only to put down a duplicate plant so far as cells are concerned, but also to duplicate the boilers steaming in connection therewith. When this is done, regular periodical inspection and cleaning is possible, risk of stoppage is eliminated, depreciation is reduced, efficiency and economy are conduced to." We feel we cannot too strongly controvert such a statement as this. Is it seriously proposed to duplicate all the costly plant which has hitherto been laid down for the purpose of destroying refuse? If so, we can only say that in our opinion such a course would be financially suicidal. When we consider that on plants designed for destroying refuse and developing the power obtainable, the bill for interest and repayment of capital and depreciation already amounts, as the rule, to something like 6d. per ton, which is a very large percentage of the total cost of burning, we cannot consider this proposition as reasonable. With a properly constructed plant there should not be any necessity for frequent stoppages, either for cleaning or repair; and, in fact, the experience of such towns as Birmingham, Liverpool, Bradford, and Leeds, proves the exact contrary. All the necessary cleaning can be effected on Sundays, and the repairs can be done at holiday times, except when relining has to be resorted to, which is not found to be the case more often than once in 4 or 5 years. We do not think depreciation would be reduced by having duplicate plant working alternately. On the contrary, the constant heating and cooling of the furnaces would be quite as serious in causing wear and tear as the continuous use of the furnaces. Such a recommendation as this appears to us to be a serious blot on a book in which there is much advice of a practical and sensible nature.

It is also disappointing to notice in a book which deals with essential points connected with destructors, the absence of exact data on various important points which seriously embarrass engineers who have not specialised in this line. For instance, although a chapter is devoted to "boiler setting, brickwork and flues," no rules are laid down as to the area of chimney and flues required to deal with a given grate area designed to burn a given number of pounds per square foot per hour; nor is there any information on that vexed question of dampers, which are an endless source of trouble to all persons dealing with hot gases. They are dismissed with two short paragraphs stating that they should be "simple, counterbalanced, and working in a slotted frame," and that "they are often jacketted with the best firebricks or slabs, and they do not give much trouble." The usual experience of dampers is that they give a great deal of trouble when used to regulate very hot gases.

The author has been accused in some quarters of partisanship, and he is certainly a partisan of forced draught and high temperature; but on the whole, we must admit that the book is a fair and free criticism of existing destructor practice. The prominence given to the author's firm is not unreasonable when due allowance is made for his position; and other firms are generally given the credit for what they have done well, in addition to unstinted blame where the author considers they have gone wrong.

The author is somewhat prejudiced, evidently, in favour of steam jets, but he, unfortunately, omits to state what amount of steam is required to deliver a certain quantity of air at given pressure in a given time by this apparatus. He states the amount of steam used in percentage of the total steam raised, which is of little or no advantage to the inquirer after knowledge. Exact data on this important point would have been most useful, and we think would have demonstrated that a well-designed fan uses about one-fifth

of the amount of steam required by a steam-jet apparatus to deliver the same quantity of air. On the other hand, it must be admitted that in many cases steam appears to greatly assist combustion in furnaces burning such low grades of fuel, in addition to prolonging the life of the grate bars.

Again, in reference to chimneys, Mr. Goodrich states that "where the available heat from a destructor is fully utilised, it is possible to considerably reduce the height of the fire-brick lining, even if it is not possible to altogether dispense with it" (p. 86). This appears to us to be advice which no prudent man will follow, for although we have heard of destructors where no bye-pass was provided, we hold that no prudent man would instal boilers for gas-firing without providing a bye-pass to carry the hot gases off when necessary. The moment such a bye-pass is opened, the chimney receives the hot gases at only a few degrees lower temperature than that at which they left the furnaces, and if the chimney is unlined, the resulting damage to the shell will be exceedingly serious.

We note that in the portion referring to London, the old division of the London districts, which prevailed before the establishment of the Metropolitan Boroughs, has been adopted. This is practically the only point upon which the book is not well up to date.

Long lists are given of the various towns with their populations and their positions in regard to disposal of refuse, which will no doubt be of great value to destructor builders and others specially interested, but which will not appeal to the general reader.

An interesting chapter follows on refuse disposal in America, from which it would appear that considerable progress is being made on that Continent, though actual destruction is only now beginning to take the place of the reduction and utilisation processes so much employed in the past. These processes have sometimes been found profitable, but almost always productive of nuisance, and it is satisfactory to know they are gradually being abandoned.

Refuse disposal in Europe, South Africa, India, South America, and Australasia, and in the East, occupy subsequent chapters, and then comes a further instalment of technical matter under the heading of "Types of Destructors." We prefer not to follow the author too closely in this department of his book, lest we also should unjustly be accused of bias. The descriptions of the various systems appear to have been taken largely from the builders' own pamphlets, with Mr. Goodrich's trenchant comments added thereto. In some cases the makers' addresses are given; in others, we presume, it has been considered unnecessary to mention them.

The important subject of the separation of dust from the destructor gases is treated somewhat fully, but not in such a manner as to guide the uninitiated in overcoming the difficulties of the process. It is a good thing, however, to find the necessity of arresting the dust insisted upon.

The utilisation of residuals, so important from an economical point of view, and, finally, the several methods in vogue for the collection of refuse, receive attention.

While we cannot give to this work unmixed praise, we must conclude by congratulating the author on his industry in collecting and setting forth such an enormous mass of facts, and upon the general fairness and marked ability with which he has treated a most difficult and thorny subject.

Designing Ironwork. Second series, Part II. By Hy. Adams, 60, Queen Victoria Street, London. 1901.

This is a pamphlet of notes, formulæ, calculations, and working drawings for built-up steel struts or stanchions. A special case is taken in the shape of a 30 ft. high built-up post to carry 60 tons standing alone; the calculations are detailed, and it is shown how strength depends on various factors, and the relation of length to diameter. The elementary working strength of mild steel is taken at 7½ tons tension, 6 tons compression, and 5 tons in shearing.

In column form this elementary strength may be reduced as low as 2·5 tons for compression when the length is 40 diameters. The author quotes Mr. Shaler Smith's sliding factor of safety, and gives various practical notes. He also shows the method of calculating moments of inertia of sections, and gives various long column formulæ, of which there are so many—every bridge designer in America of note appears to have some modification of the well-known Gordon formula, and it is far from satisfactory to have a table of results for the same piece which vary from 57 to 177 tons, according to the formula used.

Some figures are given for pressures on foundations and other useful information is added, concluding with an extract from American standard specifications of structural steel. We have already drawn attention to these specifications, which permit of 0·10 per cent. of phosphorus—an amount that will appear high to our own steel makers, and that ought to be noted when foreign steel is in competition with English steel.

The Telephone System of the British Post Office. By T. E. Herbert. Second Edition, Revised with Additions. London: Whittaker & Co., 2, White Hart Street.

In this new edition a chapter on "Recent Advances in Switchboard Designs" has been added. This chapter briefly states the principle of the "central battery" system which the Postal Telegraph Department is adopting for the London telephone system. The new chapter consists of but six pages, and describes the "Central Battery Automatic Multiple" system, the "Kellog" system, the "Chicago Express" system, and the "Sabin's Divided Board" system. In the central battery automatic system, the removal of the receiver from the switch-hook at the subscriber's end lights a call lamp, and the replacement of the receiver lights a clearing lamp; no batteries are required at the subscribers' offices. In the Kellog system every connection is dealt with by one operator only, so that the waste of time inseparable from junction-worked systems is avoided.

ELECTRIC TRACTION BATTERY TESTS.

By RANKIN KENNEDY.

The auto-car people don't seem to be able to discriminate between battery tests and car tests. The *Automotor Journal* takes exception to my recent remarks on the long run trials of the electric car "Powerful," in which I did not disparage the motor at all. What was called in question was the claim made to the effect that these runs proved the superiority of the battery; my contention is that they prove nothing one way or the other, except the durability of the cells if the runs are repeated often enough. These runs are really tests of the car as a whole. How much or how little of the success is due to the battery cannot be known. How can any reliable comparison be made between this battery and all others, without subjecting the best of the other batteries to the same runs on the same roads on the same car?

Laboratory tests are avowedly not acceptable to auto-car men, and rightly so; but the tests which the auto-car experts substitute for laboratory tests, and upon which they place so much reliance, ought to be such as can give absolutely definite and acceptable results.

In all tests the results must be compared with some standard to give any idea as to their value. The road run test is the only one of value, but if it is to be a test of the battery, then the same car on the same roads must be run under the same conditions with several different sets of cells.

I would propose that a test should be made of batteries, open to all makers, the car battery to be made up of so many cells of each make, coupled up to form one battery on one car; say, 10 competitors each to put in four cells to make a battery of 40, and no series parallel battery coupling to be allowed. Then from the tests ascertain the watt-hours per pound of cell for each make in actual runs, all under exactly same conditions.

The car runs to be stopped when the cells of any make drop to 1·7 volts, with the normal current flowing, and the remaining cells discharged at normal rate until down to 1·7 volts, the last cell to drop to this P.D. being adjudged the best. It is a simple test; the details can be easily worked out, and it would give some rational acceptable results; no others can be accepted by engineering experts.

The results of the runs of the "Powerful" are very creditable to that car as a whole; but to claim them as tests of a battery will do more to disparage them than anything I can write. I rather fancy battery makers will be almost as reluctant to make the road tests on searching lines as they are to make the laboratory tests, because "comparisons are odious," you know.

I have been repeatedly twitted about my letters to the Electrical Review, written 20 years ago, and as the *Automotor Journal* kindly offers to refer me to these letters again, it may afford an opportunity for an explanation which advocates for alternating current systems may also please note.

The distribution of electrical energy by alternating currents and transformers at this very day still requires an amount of copper which can only be described as "prodigious," when compared with the present day continuous current systems.

I consider my views were then correct, and 20 years of practice only clinches my arguments. I looked upon the high pressure feeders and the transformers as additional copper required over and above the low pressure network, and an examination of alternating systems proves that it is so.

A three-wire 500-volt continuous system requires much less copper in municipal supplies than any alternating system; this latter had its day, now gone for ever, when lamps were only 100 volts, or 120 at most, and consumers were few and far between, and were wealthy people requiring only good lights; the conditions are now totally different.

GLASGOW INTERNATIONAL CONFERENCE. SOME IMPRESSIONS.

The International Engineering Conference in Glasgow has come and gone, and probably there are many divergent opinions in the minds of those who were present, as to whether any direct or indirect advantages to the world of engineering are likely to arise from this most notable assemblage of engineers and men of science.

As the Electrical Section is the one in which our readers are mainly interested, our remarks will be for the most part confined to that, and will supplement our somewhat exhaustive comments of August 30th, when only the titles of the papers were known to us. Indeed, so far as several of the papers are concerned, they were there and then treated far more fully in our pages than at the time when they were read. It seems hopeless to expect that those who are responsible for the compilation of the programme for each day at these gatherings will ever learn wisdom, and what we said of the proceedings of the Municipal Electrical Association in our issue of June 28th applies equally well to last week's conference.

Let us turn to the programme of Section IX. The first day was uneventful, simply a paper by Mr. W. B. Sayers, "Notes on the Electrical Exhibits in the Exhibition," followed by an organised visit to view them. This latter function could very well have been omitted, as members had ample opportunities of seeing the electrical exhibits in a more leisurely manner during their stay in Glasgow, and another paper might have been read and discussed with advantage; as it was, no less than four papers were crowded into the three hours of Wednesday morning.

That of Herr Lasche on the "High-Speed Railway Car of the Allgemeine Elektricitäts Gesellschaft," consists of a pamphlet of 43 pages, illustrated by 30 figures, and two large sheet drawings of the car. Prof. Jamieson's paper ran into 14 pages, Mr. Dick's into 22, and Prof. Maclean's into 29, all profusely garnished with diagrams and blocks.

Herr Lasche read his paper in abstract, a lengthy one by the way, and when some half-dozen gentlemen had indulged in platitudes, sandwiched between personalities which had been better left unsaid, nearly two hours had passed, and the President had to declare as ended a discussion which had barely begun, and which could have lasted with advantage till the hour for rising. Indeed, if the President had but announced that as the subject was of such vast importance to the electrical engineering world compared with the three papers which followed, he considered it would be advisable to take the others as read and continue the discussion, we feel convinced he would have carried his audience with him and the three authors as well.

However, an attempt was made to read the second paper, but the author can scarcely be congratulated on his efforts. Mr. M. B. Field then opened the discussion with some written comments which we know to have contained valuable criticisms, but before he was through he was told to communicate his remarks to the *Proceedings*, and thus ended the second lesson.

Twenty-five minutes were left for the papers of Mr. Dick and Prof. Maclean, which were simply glossed over, and no attempt made at discussion through want of time. One gentleman close by us had come from London on purpose to speak on "Electrolytic Meters," and his chagrin can be better imagined than described; generally, so far as we could gauge the feeling of the gathering, it was one of discontent and dissatisfaction.

The third day saw no improvement, for after Mr. Field had abstracted his own paper on "The Relative Advantages of the Three, Two and Single-phase Systems for Feeding Low Tension Networks," and a brave attempt had been made at discussion, the remaining papers on "Modern Commutating Dynamo Machinery" and "Continuous Current Dynamo Design" were read in abstract one after the other, and discussed *together*.

As if this were not enough to distract those who went to learn, there were electrical papers read in three other sections on Tuesday, in four on Wednesday, and in one on Thursday, besides other papers of indirect interest to the electrical engineer. Not being an Irishman or a bird, or, as the Scotchman said, not being "ampheebious," we could not be in two places at once, let alone five, and how some of the papers received any attention at all when scattered over so many sections is beyond our comprehension.

As an example we may point to the paper on "The Economy of Electricity as a Motive Power on Railways at Present Driven by Steam." This was read in full in Section I. on the first day, and only two gentlemen attempted to discuss the matter, neither of whom could be called competent to deal with a subject of such world-wide importance. The author, Prof. Carus-Wilson, was greatly disappointed, as we happen to know. This can scarcely be wondered at, and we sympathise with that gentleman, for the paper was practically lost, notwithstanding that it was read in the section devoted to railway interests. A paper on "The Uganda Railway," of the baldest kind, delivered in a series of almost incoherent jerks, and illustrated by pretty lantern slides, attracted far more attention, although compared with Prof. Carus-Wilson's it had no far-reaching value for the railways of the future.

In all there were some 16 papers which may be called strictly electrical, and half of them at least were of real and lasting value to the interests of the profession, but when one considers that the time of the Institution is oftentimes taken up for three meetings in discussing one paper, what earthly chance, what pretence was there, of doing adequate justice to the papers brought up at Glasgow?

And then as to the nature of the discussions. When Mr. Field had read his paper, Mr. Kapp was called upon, and excused himself on the ground that he had had no time to study the paper; Mr. Eborall would send in his remarks to be printed in the *Proceedings*; Mr. Zipernowski's English was not good enough; Prof. Carhart had only glanced over the paper, and so on.

These gentlemen cannot be blamed; it was quite impossible, without having had a chance of studying them beforehand, to read, learn, and inwardly digest such a plethora of papers, several of which would each fill nearly 20 columns of the Review's small type.

In one, if not more, of the other sections, papers had been requested, the reading of which should not occupy more than 20 minutes, and we have by us quite a number confined to seven or eight pages; surely a similar course would have been of inestimable value in Section IX!

We were struck with the large proportion of young and new men, and the strange absence of many of the better known members of the profession from Section IX. Still, there were present enough of the latter to enable the tradition to be kept up of calling upon the same men to open nearly every discussion,

whether they had any real practical knowledge of the subject or not, and many of those engaged in the actual business of the topics brought forward were never called upon to speak. It was the old, old story, we heard the usual platitudes, the speakers invariably wasted valuable time by congratulating the authors on their valuable work, passing insincere compliments, and finally wandering off into side issues.

The manner of reading is open to much improvement. The authors simply bend forward and read to the small table desk on which their papers rest. Those who carry on the discussion look fixedly at the chairman, and apparently direct their remarks to him alone, and the difficulty of hearing experienced by those who are anywhere near the back of the lecture theatre is such that it can occasion no surprise that there is an incessant disturbance made by those who, not being able to catch what is being said, simply get up and walk out. This is only equalled by stragglers, actuated more by curiosity than by any serious desire to participate in the morning's work, forcing their way in.

The only men who really made themselves heard, who could fluently express what was passing in their minds, and who directed their utterances straight to the audience, were Prof. Silvanus Thompson—a past master in the art of debate—Mr. Gisbert Kapp, Mr. Chamen, Mr. Rathenau, a gentleman from the Continent whose name we missed, Mr. H. A. Mavor, and possibly one or two others.

A most extraordinary example of the act, practise, or art of uttering aloud the words from a book, manuscript, or other written or printed production, was given on the final day of the Conference.

In a curious monotone, pitched somewhere between alto and soprano, the author just went on at the speed of a Behr mono-rail 110-mile an hour train, the effect being not only ludicrous to a degree, but absolutely unintelligible.

The necessity for good articulation and some elementary knowledge of elocutionary effort was never more painfully apparent than during the reading and discussion of the Glasgow papers.

Judge Curler, who was brought over from America to give evidence in the recent trial of Earl Russell, says that the English are poor speakers. "One thing I noted particularly," he remarked to the *Tribune* reporter. "Earl Russell's lawyers did not compare with American lawyers either in skill or in forensic powers. The English, in fact, are not as good public speakers, usually, as Americans are—a fact which I noted also at the dinner given by the New Vagabond Club and at the American dinner. At the trial, indeed, the prisoner made by far the best speech, and he was the only person who was audible over the entire House."

Let our embryo Faradays, Clerk-Maxwells, Kelvins, Hopkinsons and Kapps of the future take this to heart, and make better use of debating societies, which ought to exist, if they do not already, in every town in the United Kingdom. Elocution, the art of correct intonation, inflection, and gesture in public speaking, does not seem to be studied by the majority of those who are called upon to contribute to a discussion on technical matters; but it is only by such application that one can give natural expression to thought by appropriate speech, without adopting an artificial or ornate delivery.

John Gladstone, the father of the great Liberal Prime Minister, trained his children to give a reason for every opinion they offered. It was in this way that William Ewart Gladstone was educated as a debater from his youngest days.

During the discussion on Herr Lasche's paper, allusion was made in what may have been a spirit of banter, although to us it savoured of something deeper, to the experiments made by Sir William Preece on the Metropolitan Railway, and the large sum of money expended by the company in demonstrating that electric traction was possible, which everybody had known for years. Money, it was said, was plentifully forthcoming in Germany for the carrying out of useful experimental work, while here large sums were wasted on useless experiments, though but little could be found for legitimate pioneer enterprise.

To give money freely for the purposes mentioned in the discussion, financial groups must have faith and perfect confidence in the promoters of the proposed schemes, and particularly must it be felt that they are engineered by men who are not only thoroughly acquainted with railway work as it exists to-day, but are also perfectly conversant with what has been done in electric traction so far as it has gone. Until we can place implicit trust in promoters and consulting engineers, pecuniary aid for experiments calling for heavy outlay will naturally be withheld; possibly in Germany the *bona fides* of financial and technical classes is better understood.

Whatever the result of the Conference as a whole, we returned only with a sense of disappointment, and much as we had hoped to the contrary, we doubt whether the interests of the electrical trades outside Glasgow have been furthered in the slightest degree. Perhaps, however, that was not the object of the meeting, and although at one with our worthy President's opening address, we see but little to make us optimistic regarding the good to be derived from the Conference except to the second city of the Empire; this, however, is in itself a matter for hearty congratulation, as so much of the engineering and shipbuilding prosperity of the Empire is centred in and around Glasgow.

CORRESPONDENCE.

Furnace Temperatures.

I note the criticism of Mr. Garrard upon my article on "Furnace Temperatures," and while I am in agreement with him as to the temperature given by me not being actually attained, I think it quite allowable to calculate a so-called theoretical temperature with the factors—calorific capacity, nominal specific heat, and weight of product. The action of dissociation, or rather, of non-association at high temperature, may prevent the attainment of a temperature of, say, 5,000°; but, the potentiality of heat being present, if the mass be doubled by the addition of a neutral gas of equal specific heat, the half temperature of 2,500° would be attained even if the maximum temperature had only reached, say, 3,500°. The reason is that the gases that did not associate at 5,000° would combine as the temperature was reduced, until all had combined. It is claimed by the dissociation school that the non-attainment of high temperature is due to dissociation alone, but this is very doubtful. It is probable that the cause is the increase of specific heat at high temperatures. This has been thoroughly investigated by M. Berthelot. In giving 4,892° as the temperature of combustion of carbon in the minimum sufficiency of air, I did not overlook either the dissociation or the increased specific heat. While, therefore, Mr. Garrard may be perfectly correct in stating 4,172° as more correct, he does not help us to find the final temperature of the much diluted products, for the heat which does not appear at the higher limit of temperature all comes back or reappears as dissociation ceases and specific heat falls. In a boiler furnace there is so much excess of oxygen above the so-called chemical minimum that, given time and heat and mixture, the law of mass action may be neglected, and complete combustion will occur. Thus under the practical conditions of the furnace we may neglect to consider mass action, or specific heat variation or dissociation, because we find the gaseous products below that part of the temperature curve that is bent from the straight line by their action.

Again, as regards the evaporation of carbon, though this probably occurs at about 3,600° C., just as ice evaporates at 100° C., may we not properly assume that it evaporates at about 500° F. when combined with hydrogen, just as ice at 32° F. will evaporate without liquefaction in a cold breeze? The latent heat of evaporation is called for, and that is what lowers the furnace temperature.

In assuming that carbon required 5,817 units of latent heat, *i.e.*, the difference between the first and the second oxidation to CO and CO_2, I did so as I did not wish to overstate the case. I am writing away from my books, but I believe that Berthelot states the heat generated by the second oxidation of carbon as 42·1 calories per molecule, and that generated by the first oxidation as $42{\cdot}1 + \varepsilon$; ε being an

unknown but suspected amount of heat not yet determined, and therefore took the smaller figure. Any larger figure would reduce the temperature in the furnace to less than my figure. As I stated in the footnote to my article, the figure 7,000° was probably overstated for the latent heat of all the volatile parts of bituminous coal. This figure will vary with the amount of oxygen and nitrogen present in the coal. We may say that carbon has 6,000, hydrogen 7,320, but oxygen and nitrogen have a much lower figure, and if present in large quantity will lower the average considerably. Thus the worst coals probably suffer less from temperature reduction at the furnace than the better coals and may be less smoky. It is to be hoped that the true heat of vaporisation of carbon may be ascertained. Possibly the electric arc will furnish a means of doing this.

Thanking Mr. Garrard for his very interesting figures—

W. H. Booth.

Dinan, *September 7th*, 1901.

Apprentice or Pupil?

At a time when so much earnest thought is happily being given to the true training of practical electrical engineers, as witnessed by the correspondence and many able articles which have, of late, appeared in the Electrical Review, all bearing on this question, may I be permitted to raise, through your columns, a point touching the practical part of all engineers' education.

Should they "serve their time" as apprentices or pupils? I quote a few lines from a letter of one of your last week's correspondents, "Fiat Justitia." He says:—"I should like to ask what sort of men we shall admit to the profession if they can enter without being put to any expense? I presume a youth (or his parents) not only thinks of his liking and qualification for the work he enters on, but the *social position* and *men* he will have to mix with." (The italics are my own.)

Assuming, for argument's sake, that money is nowadays any criterion of birth or social position, are, then, young Englishmen to be debarred from entering the profession of their choice, to which they might one day do much credit, by the heavy premiums exacted by many British firms?—since their parents may not be in a position to pay such heavy premiums, and are, therefore (as a natural corollary from your correspondent's statement), of inferior social position to those who are. Surely, Sirs, it will appear to most of us that the question of social status is hardly one that should weigh with a man who has at heart the true interest of engineering enterprise and industrial progress.

I fear it is such sentiments as those expressed by your correspondent that have tended to lower the standard of professions other than engineering. Is it not a fact—a notorious fact—brought prominently to light by the recently proposed military training reforms, that young fellows are utterly unable to enter any cavalry regiment unless they can command private means of at least £600 a year? I may perhaps be accused of straying from the point, but the above fact appears to me to bear a close analogy to the question under discussion.

Surely the expense attached to the proper training of a young engineer, what with college and lecture fees, to say nothing of his keep during the long years of his training, is great enough without having to pay a heavy premium!

What real advantage has the "premium pupil" over the apprentice engineer while "serving time"? The same correspondent says:—"He will be allowed to go through the shops, drawing offices, &c., while the apprentice may be kept to one specialty; the workmen will also be more civil and willing to teach him."

Sirs, I am a young apprentice engineer in the shops of one of the largest mechanical and, at the same time, electrical engineers in Scotland, and can only say that I have reason to congratulate myself on not being a "premium pupil."

Although every apprentice has to work hard, he is given a variety of work and gets shifted into different shops from time to time.

With regard to the journeymen, although they are, I think, among the roughest of their class, they always, as far as my experience and observation goes, recognise a true gentleman, and treat him accordingly, and are willing to teach him anything. May I go so far as to say that in my opinion the advantages of a premium pupil over an apprentice are imaginary; on the contrary, let us reverse the question and say: What real advantages has the apprentice over the premium pupil?

1. He has to keep regular hours, including regular early morning rising, when some of the most important work of the day is often carried out.

2. He is made to work hard, and thus learns what hard work is.

3. He works for a *definite wage*, which, to my mind, adds a tremendous stimulus to one's work, no matter how small the pay may be—I do not believe it is in the nature of things for man or boy to work *well* for nothing.

I believe it is a fact well authenticated that the late Lord Armstrong was known to say to one of his many heavy premium pupils that any son of *his* going to be an engineer should serve his time as an apprentice.

I have only to add, after apologising for the length of this letter, that I honestly believe that our engineering profession will be benefited when other firms, like the one with which I am serving my time, refuse to accept "premium pupils."

Apprentice.

Jandus Lamps.

We have noticed in your current issue that the Jandus Electric Company, of Cleveland, Ohio, have sent you some lists referring to their Jandus Arc Lamp (page 391 Electrical Review.) As this might give rise to some misunderstanding on the part of arc lamp buyers, we beg to point out that Jandus Arc Lamps can only be made in England by the Jandus Arc Lamp & Electric Company, Limited, of Brown Street, Manchester, and sold by us or our supply agents.

We would venture to offer it as our opinion that the Cleveland Company had no intention whatever of selling Jandus Lamps in England, as the Jandus Arc Lamp and Electric Company, Limited, possess and intend to uphold all patent rights, &c., for Great Britain.

Drake & Gorham, Limited.

September 9th, 1901.

Coal Consumption per Unit in Traction Stations.

In the very interesting article in your issue of 30th ult. *re* the International Engineering Congress, I notice the following paragraphs:—

1. Enthusiasts like Mr. Langdon, the estimable president of our Institution, may talk about power for 3 lbs. of coal per unit, but do they really speak in full possession of the facts?

2. At all events, facts in electrical tramway practice point to the expenditure of 6 to 14 lbs. of coal per unit, 6 lbs. for a load factor of 45 per cent., and 14 to 16 lbs. for load factors of 16 to 20 per cent.

The expenditure as stated may be the general experience in many power stations, but there is no reason why better results cannot be obtained where the stations are properly designed and efficiently managed.

The writer is a charge engineer in a tramway power station with a load factor of 50 to 55 per cent., and having full possession of the facts, is in a position to say that power can be obtained from less than 3 lbs. of coal per unit.

The output sheets for both shifts (eight hours each) to-day show the following results, which is about our usual experience:—

No. 1 sheet, 2·1 lbs. of coal per unit.
„ 2 „ 2·36 „ „ „

I, therefore, quite agree with Mr. Langdon that it is quite possible to produce power with the expenditure he states.

Trusting this may open up an interesting discussion on the subject.

W. H. J.

[Our correspondent's figures are extraordinary, even for such a high load factor. Further particulars would, we are sure, be heartily welcomed by our readers.—Eds. Elec. Rev.]

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THE BOARD OF TRADE REGULATIONS.

We were unable in our issue of August 30th to comment on all the papers brought before the Engineering Congress, although we touched upon a considerable number. That by Mr. M. B. Field, on "The Relative Advantages of Three, Two and Single-Phase systems for Feeding Low Tension Networks," we were compelled to leave for the moment, but we now offer a few remarks on the subject, which is of immense importance at the present time.

The Board of Trade regulations relative to high tension working with three-phase currents (for instance, a 10,000-volt three-phase system) are simply ridiculous, and will undoubtedly retard the development of three-phase working in this country. For instance, with underground three-phase cables, they stipulate that if these are laid on the solid system the troughs shall be bonded, or if the cables are simply armoured cables laid in the ground, they shall either have an abnormally heavy sheathing, or preferably an extra copper sheathing laid on underneath the original armouring. This copper sheathing (or the heavy armouring or the iron troughs) would, of course, be earthed, as well as the centre points of the star connections on the machine. By forcing people to use this expensive construction, which we think is totally unnecessary, many engineers in this country are being simply compelled to put down the two-phase three-wire system, which, of all the polyphase systems, is the worst, for it requires an abnormally large weight of copper to transmit a given power under a given voltage, and good pressure regulation (on account of the interconnection between the phases) is rendered difficult with inductive loads,

The Board of Trade idea is that the sheathing, or equivalent device, is necessary, so that should there be any leak from any phase to earth, this leak will be a short-circuit and enable the safety devices to cut out the cable. For instance, if a pick should be driven through the cable, it will first have to go through the sheathing of good conductivity connected to earth, thus causing immediately a short circuit as soon as the pick touched any conductor of the cable.

They hold the view that a normal steel sheathing is not sufficient, on account of its inferior conductivity, and because it may be eaten away by the action of the soil.

The South Lancashire Tramways Company and the Midland Power Company, which are both polyphase schemes of large magnitude, involving pressures of 7,000 volts or thereabouts, and many miles of feeders, are two schemes which have been, in our opinion, quite spoilt, owing to the adoption of a two-phase three-wire system. We learn that this course was adopted simply on account of the heavy outlay entailed in complying with the Board of Trade regulations. Doubtless many other of our coming large power schemes will suffer in this way. The Board of Trade also have very curious rules as to the amount of power which is allowed to be transmitted by a given cable, and relative to the thickness of insulation between the conductors of high tension cables. These rules may, or may not, have been necessary in the early days of single-phase working, but, under modern conditions of high tension three-phase working, they are unnecessary and ridiculous.

In the discussion on Mr. Field's paper, the use of single-phase systems for large power work was advocated by some, which simply serves to show how far we are behind when tackling the practical problems of power transmission by electricity.

Motor Vehicles in Warfare.—The War Office trials of self-propelled lorries for military purposes are to be made about the first week in December. It is expected that there will be 20 to 30 entries. Five routes in Surrey and Hampshire have been selected, the longest being that from Aldershot to Chatham,

THE GENERATION AND TRANSMISSION OF ELECTRIC ENERGY AT AND FROM COAL PIT CENTRES.

By B. H. THWAITE, C.E.

(*Continued from page* 346.)

Poles.—The only kind of poles suitable for high pressure electrical transmission work are those made of Norwegian fir, American redwood, and American hard yellow pine. Iron *per se* is quite unsuitable.

The dimensions of the poles should be generously proportioned, and they should have sufficient altitude to maintain the lines well out of possible influence effects by or from other conductors that may pass under them. The structural proportions should be adequate to withstand all atmospheric influences, such as snow, ice, fog, sleet, hail, and rain.

The poles should be well bedded in concrete. For this purpose high-class Portland cement and clean gravel and sand, in the proportion of 1 of Portland cement to 3 of gravel and sand, will provide an ideal concreted base formation. For general applications 50 poles to the mile is good practice.

The poles, before being erected, should be creosoted—that is to say, petroleum should be injected into the previously dessicated wood, by means of hydraulic pressure.

Characteristic dimensions of poles carrying the high pressure line:—Length, 53 ft.; diameter (top), 7-8 in.; diameter (within 6 ft. of butt end), 16-17 in.; set in ground to a depth of 7 ft. 6 in.; weight about 12 cwt.; cross-arms, 6 to 9 ft. long, with a cross-section of 5 in. × 4 in.

With long arms, it is structurally necessary that they should be braced with suitable brackets, and the arms should be secured to the pole by means of strong iron through bolts; the arms should be placed as high up the poles as is practicable. See figs. 25 and 26.

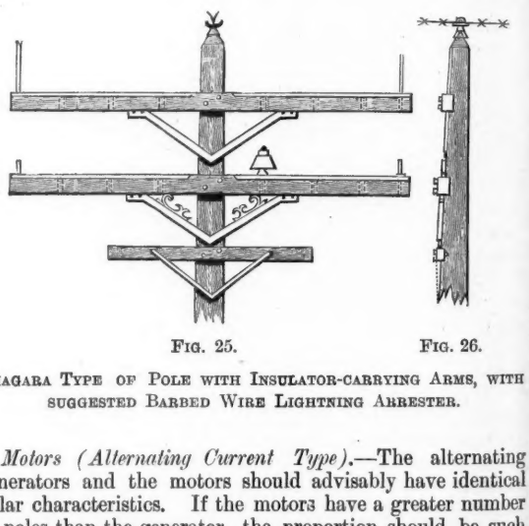


Fig. 25. Fig. 26.

Niagara Type of Pole with Insulator-carrying Arms, with suggested Barbed Wire Lightning Arrester.

Motors (Alternating Current Type).—The alternating generators and the motors should advisably have identical polar characteristics. If the motors have a greater number of poles than the generator, the proportion should be such that the influence of the poles of both generator and motor will exactly synchronise; for example, if the motor has twice the number of poles of the generating machine, the two will synchronise when the motor runs at half the speed of the generator. All the qualifications definable for a perfect type of alternator generating machine are applicable to the alternating current motor.

When the motor acts in perfect synchronism with the electric generator, it absorbs power in remarkable sympathy with its associated generator, and within the limits of its own capacity for work. Objectionable induction influences and other complications are practically eliminated, so much so, indeed, that the motor can be employed with advantage as a means of compensating for induction effects, the one qualification *sine quâ non* being that the revolu-

tions of the motor shall be of a uniform and constant measure.

The synchronous motor constitutes a load that is substantially non-inductive, so that it causes no embarrassing inductive complications. The motor can be made to serve the purpose of a condenser of great magnitude for compensating for induction effects in any part of the system; by this means the load level is kept comparatively constant.

Polyphase synchronous motors will run steadily, even if one of the phasic leads be broken; working then, even with one phase, and by increasing the degree of excitation, they will often carry for a short period their full normal load without falling out of synchronism.

Dr. Louis Bell reports a case where an accident befell a triphase synchronous motor which, nevertheless, continued in motion, driving its load of 1,700 looms for four hours, or until the mill shut down at night.

The best range of use of alternating synchronous motors is now becoming defined as commencing at powers above 100 E.H.P. The induction motor has taken its place as ideally fit for powers below 100 E.H.P.

Induction Motors.—As an example of high pressure motor work, C. E. L. Brown, to whom the world of electro-technical science is indebted for many practical improvements, and particularly for the excellence in mechanical design of electrical machinery, has built a 1,000 H.P., 5,000 volts, two-phase motor direct-coupled to a centrifugal pump, which it drives at a speed of 455 revolutions per minute; this pump, which is located at Geneva, and elevates water to a hydraulic height of 460 ft., is thus driven by what is probably the largest polyphase induction motor so far constructed.

In this type of motor the field is supplied with alternating current, and the working current is induced directly in the armature conductor. In order to obtain rotating action, the two sets of poles are arranged so that one pair provides a magnetic field with which the current induced by the other pair is able to re-act.

With this invention, by which the electric energy is delivered to the armature by induction, a great coterie of evils and disadvantages has been swept away.

The induction motor is remarkably well suited to the requirements of small and large power consumers; the maximum serviceable unit limit is at present fixed at 500 H.P.

Carefully thought-out designs for this type of motor, and accuracy of workmanship, are most essential.

For satisfying the major part of the ordinary requirements of power consumers, it is not necessary that the induction motor should have an exceptionally powerful torque, neither will it be required to carry loads in great excess of its normal full load capacity; nevertheless, a generous proportion of torque per ampere is always desirable, and this may be secured by using at starting a non-inductive resistance in the secondary circuit. At starting, the full load running torque of the motor can be obtained without exceeding the full load current.

It may be stated, that a capacity to carry 25 per cent. more than the normal load is quite sufficiently adequate except for exceptional or special applications.

The method of effecting the regulation by varying the primary voltage is not a desirable one, because the torque falls off nearly in proportion to the square of the voltage. A better method of effecting the regulation is to insert a non-inductive resistance in the secondary circuit.

The disadvantages of inadequate capacity are those due to the heavy inductance effects, and regulation is difficult to maintain for the same reason.

Any inductance motor with an unsatisfactory power factor should be discarded. A motor to be considered economically satisfactory should give a 90 per cent. efficiency at full load, and not less than 80 per cent. at two-thirds of the full load. Condensers have been used with some success for the purpose of reducing the effect of inductance.

When the polyphase generating machines have moderate inductance, coupled with a satisfactory character of motors, the distribution of energy has given most admirable results.

Although the absence of commutators from the induction motor is a valuable qualification, this advantage has not meant a lessened cost in the manufacture of a machine for a given capacity of output. The cost of winding the primary coils, the laminated character of the core, and the high-class quality of iron necessary, are conditions that involve a considerable cost.

The induction motor must be of the highest class of design and workmanship, otherwise its efficiency will be low, and this means a loss all along the line, and conversely requires for a given load an increased power station capacity, and greater conductivity area of line, and greater line weight, and the regulation of pressure becomes more difficult. If an induction motor will not give an output efficiency under the best conditions of load of from 85 per cent. to 90 per cent., there is evidence of imperfect design, material, or workmanship. It is better to have high speed induction motors with few poles than low speed ones with many poles; the latter do not possess high factors of power output efficiency.

If the building of highly efficient induction motors is expensive, the cost, great as it may be, is compensated for, by its beneficial influence on the generating station.

Starting Motors.—One excellent method of obtaining the desirable qualification of automatic or self-starting, consists in the employment of a special commutator to rectify the current applied to the main motor armature, thus directing the impulses, so as to secure a small starting torque of sufficient turning energy to bring the motor up to speed. When this is obtained, the motor falls into step and runs synchronously.

An alternating current fed into a series wound continuous current motor will start the machine, because although the armature current reverses in relation to its winding, the field is also reversed simultaneously and the tendency of the motor is to run in the same direction, and no electrical change is produced in either armature or field. The motor is started by directing the alternating current at a suitable voltage into the field and commutator winding; the machine immediately starts with a considerable torque. When the revolutions are fully equivalent to synchronous speed, a condition usually indicated by the pilot lamp being thrown into circuit by means of a small centrifugal governor, a switch is thrown over or otherwise actuated, directing the main supply of electric energy through the alternating winding, and closing the field.

(*To be continued.*)

POLYPHASE EQUIPMENT OF FACTORIES.*

By W. WYLD, Associate Member.

(*Concluded from page* 371.)

In America the induction motor has come more into general use than in this country, and I think it is very significant to note that such a firm as the Westinghouse Company, who make both polyphase and continuous current machinery, have equipped their new works at Pittsburg with polyphase motors. Some 17 of the 60 induction motors replaced continuous current motors which were originally put down to work the hoists.

In addition to those given in the list below, there are numerous other factories being driven by polyphase motors supplied with current from such large stations as the Niagara plant and several large three-phase power-distributing companies on the Pacific coast.

In Europe, too, there are many striking examples of polyphase factory plants, and those of us who attended the *réunion* in Switzerland two years ago will remember the Oerlikon Company's large engineering works at Zürich, where all kinds of electrical plant is built and where the whole works are driven by three-phase motors. Originally three generators of 200 H.P. each were installed, but since then other two units of about 600 H.P. each, coupled to Sulzer engines, have been added, thus bringing the capacity of the plant up to about 1,800 H.P. There are 94 motors throughout the works, including some 18 cranes with a total lifting capacity of

* Paper read March 27th, 1901, before the Institution of Electrical Engineers (Birmingham Local Section).

220 tons. All of these are equipped with three-phase motors. Messrs. Escher, Wyss & Co.'s works, also at Zürich, it will be remembered, are driven throughout by about 100 three-phase motors.

The fine shops of Messrs. Brown, Boveri Co., at Baden, too, many of us will remember, are driven by about 100 three-phase motors. Also the Alioth Electrical Company's new works at Münchenstein, near Bale, which are driven throughout by three-phase motors.

I remember asking the managing director of these works his opinion as to continuous current and polyphase motors, and was informed by him that they had a few continuous current motors connected to a generator, only used to show to clients who preferred continuous current, and I was assured by him that they found the three-phase plant by far the more preferable.

The number of factories driven by polyphase plants is much too great for them to be described here, but I have made a list of some of them, thinking it might be of interest to some of the members. This list, I regret to say, is not complete, but it is large enough, I think, to show that polyphase factory driving, though somewhat uncommon in this country as yet, is by no means an experiment.

In addition to those given in the list of European plants, there are several very large works in Germany, some of which many of us are looking forward to see at the next *réunion* on the Continent in the course of a few months, notably those of the Allgemeine Elektricitäts Gesellschaft, at Berlin, which cover an area of 125,000 square yards, and in which some 14,000 people are employed, and where the whole of the machinery is driven by three-phase motors, many of the tools being driven by separate motors. (They have about 700 motors in all.)

The list of examples of polyphase factory plants of which I have been able to get a few details, is much too long to read now, so I will only give a summary.

Summary of Examples.

United States of America	5	plants aggregating	7,130	H.P.
Sweden	2	„ „	4,105	„
Germany	15	„ „	7,685	„
Holland	1	„ „	460	„
Belgium	6	„ „	3,550	„
France	8	„ „	2,182	„
Spain	1	„ „	1,300	„
Switzerland	9	„ „	5,850	„
Austria	4	„ „	1,555	„
Italy	22	„ „	12,035	„
Russia	16	„ „	12,700	„
England	16	„ „	9,450	„
	105		68,192	

A brief description of some of the English polyphase plants may be of interest.

Liverpool Grain Elevator.—The first combined power and lighting plant was installed at Liverpool for the Grain Storage and Transit Company in the early part of 1897. It is a three-phase plant of 180 H.P. The lighting and power are both derived from the same circuits, and in spite of the antipathy to this practice, no difficulty has been experienced in the regulation.

Glasgow; Edinburgh.—About this time ('97) a small three-phase plant of about 100 H.P. was installed in Glasgow and another of about 130 H.P. in Edinburgh.

Sir Thomas Richardson, Hartlepool.—In the same year Sir Thomas Richardson & Sons, of Hartlepool, laid down a large plant aggregating about 1,250 H.P. There are two large fly-wheel generators and a smaller machine of 100 KW. for night shifts. In the shops are installed some 25 motors, which vary in size from 65 H.P. to 10 H.P.

General Electric Company, Manchester.—In 1898 the General Electric Company of Manchester put in a three-phase plant at their factory in the Adelphi, Salford. The generator is of 200 H.P., and the motors, 30 in number, vary from 16 to ¼ H.P.

Bristol Carriage and Wagon Company.—The Bristol Carriage and Wagon Company about this time had their works remodelled, and a polyphase plant of 400 H.P. was installed. There are seven motor circuits, one to each shop, and the motors, 10 in number, vary from 65 to 2 H.P. each. There are 750 glow lamps and 32 arcs supplied from the same generator as the motors, and no difficulty has been experienced with the regulation. This plant has given such satisfactory results that another 400-H P. generating set is being added.

Anglo-Swiss Milk Company, Aylesbury.—The Anglo-Swiss Condensed Milk Company's factory at Aylesbury is equipped with a three-phase plant. The eight motors installed vary in size from 10 to 1½ H.P. each.

North-Eastern Steel Works, Middlesbrough.—At the North-Eastern Steel Works, Middlesbrough, there is a two-phase plant consisting of two generators of 350 H.P. each, and 11 motors—six of 40 H.P., five of 20 H.P.

D. Y. Stewart, Glasgow.—Messrs. D. Y. Stewart, of Glasgow, have a three-phase plant of 450 H.P., consisting of two generators of 250 and 200 H.P., and a large number of motors.

Beyer & Peacock, Manchester.—Messrs. Beyer & Peacock, of Manchester, have a three-phase plant of 400 H.P., consisting of two generators of 200 H.P. each, and a large number of motors of 50, 30, and 20 H.P. each.

Hawthorn & Leslie, Newcastle-on-Tyne.—Messrs. Hawthorn and Leslie, of Newcastle-on-Tyne, have a three-phase plant of 280 H.P. for driving the machines in their shipyard.

W. Dixon & Co., Glasgow.—Messrs. Dixon & Co., of Glasgow, have a three-phase plant of 660 H.P., consisting of three generators of 220 H.P. each, and a large number of motors for various purposes in their chemical works.

Kirkstall Forge, Leeds.—The Kirkstall Forge Company, of Leeds, have a 150 H.P. three-phase plant in their works.

Brown, Marshall, Birmingham.—Messrs. Brown, Marshall & Co., of Birmingham, have a small three-phase plant of about 70 H.P. in their carriage and wagon building works, for driving the machinery in one of their shops.

J. Thompson, Wolverhampton.—Messrs. John Thompson, boiler makers, Wolverhampton, have recently installed a three-phase plant of 460 H.P., consisting of two direct-coupled steam alternators of 230 H.P. each, and a corresponding number of motors.

J. Rogers & Sons, Sheffield.—Messrs. Jos. Rogers & Son have recently installed in their large cutlery works in Sheffield a two-phase plant of 320 H.P., consisting of two direct-coupled high-speed generators of 160 H.P. each. These alternators have only eight poles each, which give the low frequency of 21·3 cycles per second. There are seven motors of 25 to 7 H.P. each, used for working grinding wheels, hoists, fans, stamps, &c. Owing to the low frequency a motor generator is used for arc lighting.

Patent Shaft.—Whilst at the Patent Shaft and Axletree Company's Works at Wednesbury we have a plant of 420 H.P., consisting of two three-phase generators of 210 H.P. each, and some 30 motors, varying in size from 50 H.P. to 5 H.P., the small ones being in use on travelling cranes.

As I am connected with this plant, perhaps I can give a few details of it which may be of interest.

The power house, which was built to the designs of the author, comprises boiler house, engine room, and the necessary offices, stores and test room, and is large enough to accommodate 2,000 H.P.

In the boiler house are four of Messrs. Babcock & Wilcox's water-tube boilers, of 200 H.P. each, also a feed-water heater by the same firm. The boiler house is so arranged that the coal is tipped direct from the railway siding into the bunker opposite the fronts of the boilers. These are fed by either a horizontal duplex Tangye's pump, or a Gresham & Craven line steam injector, which deliver either through the above-mentioned heater or direct into the boilers.

The generating plant consists of two direct-coupled sets of 210 H.P. each, running at 375 r.p.m. The engines are of the compound two-crank, single-acting enclosed type by the Mirrlees, Watson Company. The generators are of the well-known Brown, Boveri & Co.'s three-phase type, having rotating fields and stationary armatures, the periodicity being 50, and the voltage across the phases 350. They are "star" connected with a neutral terminal, which, as already stated, serves for lighting both arc and incandescent lamps at 200 volts. The exciters are direct-driven, their armatures being fixed on an extension of the generator shaft.

The switchboard which is fixed on a gallery commanding a view of the whole engine room, consists of two generator panels carrying main triple-pole switch and fuse, ammeter, voltmeter, and field rheostat, the latter being of the Ward Leonard make, one synchronising panel, having synchronising apparatus, main voltmeter, with three-way switch for throwing the voltmeter across any of the three phases, a recording voltmeter and fuses for the neutrals of four generators, two feeder panels each carrying two sets of triple-pole switches and fuses, and two ammeters, two lighting panels, each carrying one four-pole switch and three ammeters, one being for each phase.

The panels are of polished marble, supported on an iron framing placed 4 feet from the wall, while a glass roof and end doors keep out dust, &c., from the connections and terminals, and provide easy access to the back with a good light.

The main cables or feeders are of the British Insulated Wire Company's make, and are drawn into Doulton conduits, the power mains having three twisted cores, while the lighting mains have four cores, the fourth being for the neutral return. The sizes of these cores vary from $\frac{3}{12}$ to $\frac{19}{15}$. These feeders run from the main switchboard to distributing switchboards fixed in sub-stations at various points in the works. These distributing switchboards carry six power and six lighting sub-circuits each, with triple-pole switches and fuses for the power, and single-pole switches and fuses for the lighting. There are separate bars for power and lighting which can, in case of emergency, be interconnected by means of plugs, thus providing for supplying the bus-bars from either power or lighting feeders. A neutral bar is provided to which each lighting sub-circuit is connected, and in each sub-station the lighting circuits are balanced as nearly as possible. The sub-circuits consist of similar cables to the feeders, and are also drawn into Doulton conduits, triple-core for the motors and two-core for the lighting.

The motors have been arranged to replace separate engines, and to drive on to the existing shafting in order that no disturbance might be made in converting to the new system. The lines of shafting in most cases have been split up so as to be driven in smaller groups for greater economy.

I may here remark that the whole of the transfer was effected without stopping any of the workshops.

One of the Goliath cranes has been converted from steam to electricity, the motor replacing the boiler and engine which were previously used. The reducing gear consists of a rawhide pinion fixed on the motor shaft of the crane, which operates the various motions. The motor controller is of the Brown, Boveri Co.'s type, and consists of a reversing switch connected in the stator circuit and controlling resistance in the rotor circuit. These switches are interlocked, and the whole controlled by one lever, so that the motor is started, the speed controlled, and the direction of rotation is reversed, by the movement of this one lever.

The motor derives its current from three trolley wires fixed on the usual overhead system.

In the foundry are two new electric travelling cranes, each operated by three motors. One is for a maximum of 20 tons, and

has two motors of 10 H.P. each, and one of 5 H.P.; the other is a 5-ton crane and has two motors of 7 H.P., and one of 3 H.P. The two larger motors are in each case for lifting and longitudinal motions, and are provided with controlling rheostats for reducing the speed.

As a result of experience 10 additional cranes are now being fitted with three-phase motors and controllers, and another generating set of 500 H.P. is being erected in the power house.

The lighting of the works is done by some 500 glow lamps and 60 arc lamps; the latter are run six in series on the 220-volt mains, and no difficulty has been experienced in the regulation, although the lighting is taken from the same generators as the motors. The whole of the wiring for the lighting is enclosed in "Simplex" steel conduits.

Since the plant was started over a year ago, it has worked most successfully. The economy has been very marked, and will show still better results when all the cranes which are now being converted are electrically driven, and the new plant is in operation.

During the recent inquiry of the Parliamentary Committee upon the Electric Power Bills there was a good deal said about the effect of a good load factor upon the cost of generation of electricity.

As is to be expected, we get a very good all-day load on my station, and instead of getting a load factor of 11·05 per cent., which is the *average* of all the supply stations given in *Lightning's* table of costs, the load factor for the past year on our station was 42·01 per cent.; and with an output of 554,000 B.T.U. per year the works cost of generation, viz., coal, water, wages, oil and stores, works out at the remarkably low figure of ·552d. per unit, while the cost of distribution, *i.e.*, the motor attendants, crane men, and arc lamps trimmer, &c., works out at ·215d., so that the works cost of the energy delivered at the shafting or machines is ·552d. and ·215d. = ·767d. per B.T.U. I do not mean that this low figure is necessarily due to the plant being polyphase, but I thought that this data would be interesting, inasmuch as it bears out to such a marked degree the effect of the load factor on the costs.

Bolckow, Vaughan & Co.—As a further sign of the growth of favour for polyphase plants in the country, I may mention that Messrs. Bolckow, Vaughan & Co., the large ironmasters, are now erecting a power station at Eston, near Middlesbrough, for the driving of their works and the lighting of the town, and this is to be on the three-phase system.

The size of the first generating sets, of which two or three are being installed, is 1,500 H.P. each.

It is seen, then, that since the introduction of polyphase factory equipment into this country in 1897, there have been no less than 16 installations started, amounting in the aggregate to about 10,000 H.P.

I venture to think that the growth to this amount of a system in its first four years in this very conservative country of ours promises well for its success and development in the future.

[An appendix to the paper gave long lists of European and American polyphase installations.]

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Sept. 11th, 1900.		Week ending Sept. 10th, 1901.	
Amsterdam	£70	Aden. Teleg. mat.	£50
Bangkok	149	Alexandria	29
Bombay	36	Amsterdam	30
Buenos Ayres. Teleg. wire	88	Bombay	125
Calcutta	205	Bremerhaven. Teleg. instruments	180
Cape Town	507	Calcutta	422
Cologne	12	„ Teleg. wire	230
Copenhagen. Teleg. wire	184	Cape Town	214
Durban	906	Channel Islands. Telephones	50
East London	190	Colombo	72
„ Teleg. mat.	44	Copenhagen. Teleg. wire	48
Fremantle	2,342	Demerara	85
Gothenburg. Teleg. wire	19	„ Teleg. mat.	529
Halifax Teleg. apparatus	102	Durban	1,498
Hamburg	70	East London	46
„ Teleg. mat.	800	Flushing	30
Hiogo. Teleg. mat.	257	Genoa	82
Hong Kong	28	Ghent. Teleg. cable	159
Lisbon. Teleg. mat.	1,051	Gothenburg	864
Melbourne	2,622	Hobart	14
„ Tramway cable	1,593	Malta	26
Nagasaki	169	Melbourne	154
New York	18	Perth	110
Ostend	40	Port Elizabeth	78
Perth	260	Rangoon	335
„ Elec. motors	535	Rotterdam. Teleg. mat.	52
Port Chalmers	141	Shanghai	17
Port Elizabeth	416	Stockholm. Teleg. wire	99
Rangoon	12	Sydney	526
Rio Janeiro. Teleg. wire	196	Toronto	210
Rotterdam. Teleg. mat.	161		
St. John's (N.F.)	33		
St. Petersburg. Teleg. mat.	343		
Shanghai	184		
Singapore	277		
Stockholm. Teleg. mat.	27		
Sydney	1,466		
Wellington	27		
„ Teleg. mat.	60		
Yokohama	56		
Total	£15,786	Total	£6,299

Foreign Goods Transhipped.

Perth. Elec. goods	£788	Colombo. Elec. mat.	£32
		Demerara. Teleph. apparatus	1,328
		Fremantle. Elec. goods	3,437
Total	£788	Total	£4,797

Electric Light Fittings on Exhibition.—We have recently paid a visit to the new electric fittings showrooms of the Electrical Company, Limited, at 162, Shaftesbury Avenue, W.C. This department was fitted out at great expense, and with the exercise of considerable judgment, with a view to rendering the showing as complete and convenient as possible. After a tour through the different rooms and a general inspection of the arrangements which have been made for the exhibition of fittings to the trade and their customers when they bring them, we are convinced that it is hardly likely that anyone will pay a visit to the establishment without quickly coming across the particular kind of fittings they may be in search of. If any may happen to go with an open mind, they will find plenty to please their artistic tastes, and to harmonise with the furnishings and general surroundings of their private dwellings. We also have before us at the moment the company's new illustrated catalogue of electric fittings, wherein we find some hundreds of beautifully executed pictures of specimens of the fittings which are supplied by them. We have made a selection of a few of these to place before our readers. In fig. 1 will be seen a neat terra-cotta design of a nigger boy one-light fitting. This mischievous little rogue, as he sits twirling his thumbs, might almost be a representative of the Electrical Company puzzling himself as to which new step he shall take for pushing the electrical fittings business to best advantage. The actual height of this fitting, which, by the way, is finished in natural colours, is 30 in. There are many other like designs in terra-cotta, such as dancing girls, Greek slaves, sphinxes, &c., and fig. 2 shows a very interesting three-light floral fitting with basket boy, the overall height being 40 in. There is an extremely rich design (heliochrome printing), with real bronze foliage work, carrying a number of lights. Other bronzes may be made to special designs in various colours, according to customers' requirements. Electroliers are in evidence in variety and abundance. Some of the French designs are very handsomely cast and chased. Other specimens are in wrought-iron. Oxidised silver fittings are a special feature, as are also wrought-iron armour bright old English fittings, with repoussé work; ceiling fittings, whose artistic qualities are beyond our pen to describe; neat but simple pendants, fancy cord, stiff and three-light pendants, dining-room fittings, with special silk shades. Among the specialities in armour finish wrought-iron is a three-light counter-weight fitting, whose pleated silk shade gives it a noble appearance, and some admirable things in the way of hall lanterns. One of the latter, with cut cylinder, is illustrated in our fig. 3. Many counter-weight fittings, plain and elaborate, are included for dining room use and numerous fancy fetching designs in brackets, these being made in oxidised

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 5.

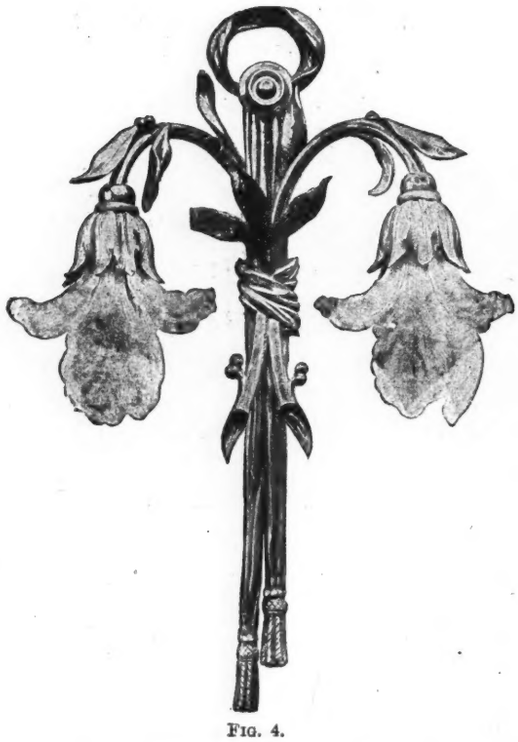


Fig. 4.

silver, brass or copper. Candle fittings, which always lend themselves so admirably to drawing room illumination and produce such a beautiful effect when suitably shaded, are fully illustrated in the catalogue, and many of them in Louis XV. and XVI. and French styles are on exhibition. A specimen of a two-light French bracket with glass Iris shade is shown in fig. 4. By the way, we must not forget to mention that one of the chief points in these floral brackets is the putting together of the flower, each of the leaves being made separate and fitted in, so that if one breaks it can easily be replaced, and the fitting is not permanently spoiled, nor does it take any great labour to repair it. Polished brass standards, bronze figures (of which we reproduce a specimen in fig. 5), onyx pedestals, and many other fittings are to be seen at the showrooms above mentioned, and are to be found very well set out in the catalogue. Other details worth noting are the new patent detachable fitting for outside window brackets, the patent universal fittings, for which the Electrical Company has the sole agency, the outside bracket and lantern for shop lighting, also their portable motor car accumulator sets, and lastly, the handy cigar lighter, which is made for either high or low voltage, and is finished in nickel and polished walnut, and has an ebonite switch. Altogether the company has an admirable showroom, well filled with all classes of fittings, and its catalogue will be very serviceable to the trade.

Battersea Polytechnic.—The prospectus of day and evening classes and schools for the approaching session has been issued. Applied mechanics, steam and heat engines, mechanical engineering, physics and electrical engineering, are among the courses arranged for, and particulars may be obtained from the syllabus which also gives pictures of the electrical laboratory, machine shop and some other departments.

Catalogues and Lists.—The Falcon Electric Manufacturing Company, of New York, has sent us a set of its circulars and pocket cards of Falcon fans and fan motors, arc lamps, knife switches, fuse panel boards, D.C. motors, switch panel boards, fuse blocks, &c.

The Monarch Manufacturing Company, of Waterbury, Conn., has issued an illustrated pamphlet of its Monarch engine stop and automatic speed limit.

From Messrs. Cox-Walkers, of Darlington, we have received a copy of their new catalogue, in which numerous illustrations, prices, &c., appear of British made telephones for table, intercommunication and other purposes; also electric tell-tales, mining bells and signalling apparatus, trembling bells, indicators, pushes, measuring instruments, medical apparatus, and many other electrical appliances and accessories.

The Ohio Electric Works, of Ohio, send us some lists of their small fan motors, toy medical coils, batteries, and other little novelties.

A sheet of illustrations comes to hand from the Isca Foundry and Engineering Company, of Newport, Mon., showing amongst other things tramway points and crossings, pumps, tanks, portable railways, cranes, cast-iron pipes.

Messrs. J. Lang & Co., of Chicago, send us a price list of their steam and electrical supplies.

The Booker Carbon and Battery Company, of St. Louis, have sent us a pamphlet relating to their Phœnix carbon and battery specialities.

Messrs. Webster & Bennett, of Coventry, have brought out a new machine tool catalogue in which they illustrate and briefly describe their boring and turning mills, multiple drills, lathes, milling machines, &c.

A set of Glasgow Exhibition pamphlets, and some of their latest catalogues, have come to hand from Messrs. Mavor & Coulson, Limited, of Glasgow. One of the catalogues contains a good deal of descriptive and tabulated information regarding direct coupled plants, multipolar dynamos and motors, switches and switchboards, portable drills, deck planers, &c., also the C.C. concentric wiring system. The catalogue is also issued in sections, viz.—Dynamo and motor section; concentric wiring section.

The General Electric Company's progress sheet for August illustrates and prices "Fibrophor" insulated staples, continuous action relay, automobile spark coils, &c.

Messrs. John Spencer, Limited, of Wednesbury, have issued a new price list of their iron and steel tubes, also trolley, arc lamp, telegraph and telephone poles.

From Mr. H. Cuénod, of Geneva, we have received illustrated lists of R. Thury's automatic controllers and arc lamps. There is a good deal of descriptive matter, and the illustrations show the parts very clearly.

The British Thomson-Houston Company, Limited, have sent us their pamphlets, No. 107, dealing with slow and moderate speed motors, enclosed and semi-enclosed, from 2 to 15 H.P., and No. 108, describing their small motors up to 2 H.P., as well as an index to the pamphlets issued up to August 31st, 1901. Pamphlet No. 109 describes their alternating current generators, and illustrates those supplied for Croydon, Wallsend, and the Central London electric power stations.

We have received from Messrs. Siemens & Halske leaflets showing their single and three-phase transformers, fuses for aerial conductors, electro-plating dynamos, and ventilating fans.

Messrs. Gambrell Bros. have issued List D, describing their galvanometers, shunts, resistance boxes, testing sets, &c. Among their specialities are a self-levelling moving coil galvanometer, enclosed plug resistance boxes, and dial resistance boxes.

We have received from Messrs. A. von Glehn & Co., leaflets showing the "Bonnafous" raw hide pinions, "Villard" friction clutches and elastic sleeve couplings, for which they are sole agents.

Messrs. Robey & Co., Limited, have sent us a most artistic and tasteful brochure, illustrating some examples of their well-known horizontal and vertical engines.

The British Aluminium Company have issued a price list of their aluminium ingots, sheets, rods, wire, &c., and of aluminium alloys.

Messrs. Alex. Wright & Co. forward their 1901 price list of electrical photometers and standards of light. Attention is drawn to the Simmance modification of the Harcourt pentane standard, and special instruments for testing electric lamps of all candle-powers, indoors or in the street, are listed. Messrs. Wright & Co. also deal in steatite, raw or worked.

Cricket.—The staff of Messrs. Drake & Gorham, Limited, having formed a cricket club, the secretary would be glad to hear from any club in the trade. Letters should be addressed to Mr. H. Beenham, 22, Wilfred Street, Buckingham Gate, S.W.

The fifth annual cricket match between the electricity departments of the Blackpool and Southport Corporations took place at Southport on August 29th, and resulted in a win for the Southport Electricity Department by 27 runs. Scores: Southport, 90; Blackpool, 63.

Dissolutions.—Messrs. C. M. Stead and F. Scott (Stead and Scott, electrical engineers, Wade Street, Leeds) have dissolved partnership. Mr. Scott continues the business, and will attend to debts.

Messrs. H. F. Clough & A. Turner (Virginia Electric Company, Southport), engineers and electricians, have dissolved partnership. Mr. Clough attends to debts.

Durham College of Science.—The North of England Institute of Mining and Mechanical Engineers, in conjunction with the Council of the Durham College of Science, has arranged a course of lectures for colliery engineers, engine-wrights, apprentice mechanics and others, extending over three winter sessions, and involving attendance at the Durham College on 24 Saturday afternoons. The fees are nominal, and certificates will be granted to students who attend regularly and pass the examinations.

Electric Illuminations.—In connection with the extensive electrical illuminations which are being prepared at Dunkirque and at Compiègne on the occasion of the visit of the Czar, we are informed that the illumination devices on the E.L.B. system are being provided by the Paris representatives of Electric Lighting Boards, Limited, on a very large scale. The new Town Hall, which is to be opened by President Loubet, and other public buildings at Dunkirque, are being entirely illuminated on the E.L.B. system, and at Compiègne alone, where the Czar will be residing for a few days, the approaches to the castle are being illuminated by devices requiring no less than 7,000 lamps.

New Water-Cooling System.—A leaflet has been forwarded to us by Mr. J. T. Pearson, of Burnley, describing his new system for cooling water without the use of cooling towers. Briefly, the system consists of pumping the hot water up to a gutter on the ridges of the roofs of the station buildings, and allowing it to flow into the rain-water trough, through the down spouts or down a blank wall to a tank, whence it may, if necessary, be pumped over another roof, and so on. The chimney may also be requisitioned by fixing a trough round it at a considerable height, and causing the water to flow over the lip of it in a thin sheet, or down the surface of the chimney, into a second trough near the base. The idea is certainly ingenious, though it is open to question whether central station engineers will appreciate the advantages of a perennial warm waterfall above and all round their electrical machinery, to say nothing of the clouds of vapour within which the buildings would be shrouded.

Prosecution.—At Belfast on Monday last J. Farguin was fined £1 for improperly connecting his electric lamps with the Corporation mains, before his installation had been passed as satisfactory.

Salford Royal Technical Institute.—We have received the short prospectus for the session 1901—2. The day classes opened on Wednesday last, and the evening classes re-open on Monday 16th inst. Full courses of instruction are provided, both by lectures and by practical laboratory work; special courses are to be given in dynamo design, electric traction, &c.

The "Technolexicon."—Dr. Hubert Jansen, of Berlin, writes as follows:—"We thank you sincerely for bringing a notice on our Technolexicon in the issue of August 16th of your esteemed journal (p. 267). We trust you will excuse us if we have one remark to offer. You say: 'The dictionary (three volumes) . . . will be in German-English-French.' This might give rise to erroneous ideas. We mean to publish three volumes, one English-German-French, one German-English-French, one French-German-English. We think it of great importance that this should be fully understood. If you would kindly bring an additional notice to this effect, you would greatly oblige us, and materially add to the obligation you have already laid upon us."

Test of a Boiler Feed Pump.—We have received particulars of a series of tests recently carried out by Mr. J. R. Blaikie, electrical engineer to the Southwark Borough Council, on a compound direct-acting pump made by Messrs. J. P. Hall & Sons, Limited, of Peterborough. The dimensions of the steam cylinders were 6 and 9½ in. diameter, and of the pump 6½ in., with a stroke of 10½ in. Superheated steam was supplied to the pump at a pressure of 160 lbs. per sq. in., and the feed water was obtained from a calibrated tank 10 ft. above the floor level. Suitable arrangements were made for condensing and weighing the exhaust steam from the pumps, and the following results were obtained:—Making 35 strokes per minute, in 20 minutes 7,329 lbs. of water were delivered at a pressure of 172 lbs. per sq. in., while 73 lbs. of condensed steam were collected. At 25 strokes per minute, the figures were 4,886 lbs. water and 56 lbs. steam, and at 16 strokes per minute, 3,141 lbs. water and 42 lbs. steam, the duration of the test being 20 minutes in each case. The ratio of water pumped to steam used is 100·3 in the first case, 87·25 in the second, and 74·78 in the third. From the above data we calculate that the steam consumption per horse-power-hour was from 57 to 67 lbs., a highly creditable result compared with the ordinary run of feed pumps. The pump itself is of simple and strong construction; the steam valves are worked by steam pressure, and are balanced, while a simple device enables steam to be passed into the low pressure cylinder, so as to start the pump under a load. Messrs. J. P. Hall & Sons have erected new works at Peterborough, where these pumps and other engine room accessories are being manufactured.

Trade Announcement.—Mr. W. H. Palmer, late of 100, Charing Cross Road, has started business at 42, Castle Street East, Oxford Circus, under the style of Palmer & Co., as electrical engineers and contractors, and has engaged the services of Mr. J. F. Davie, late of the "M.D." Engineering Company and Moody Bros., as manager to the new business. The trade are requested to forward catalogues to the above address.

Zschocke's Cooling Towers.—Messrs. Doherty and Donat, of Manchester, have executed, or have in hand, the following contracts for Zschocke's patent water-cooling towers:—Birkenhead Corporation, one chimney natural draught cooling tower; South London Electric Supply Corporation, one chimney natural draught cooling tower; Laird Bros., Limited, Birkenhead, one chimney natural draught cooling tower; Dundee Corporation, two fan-ventilated towers.

West Ham Municipal Technical Institute.—The day and evening classes of this Institute in physics, electrical engineering, and mathematics will reopen on September 21st. Mr. A. E. Briscoe, B.Sc., is the principal.

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—In his report to the Electric Lighting Committee, the electrical engineer, Mr. J. A. Bell, states that during the past year the number of consumers has increased by 176 to 778. There are now 145 public and 271 private arc lamps; 60 consumers have hired motors from the corporation with a total horse-power of 485. The total connection at the end of July last was equivalent to 79,663 8-c.p. lamps. Good progress is being made with the new works at Dee Village.

Ayr.—At the Council meeting last Monday the burgh electrical engineer's (Mr. Fuller) report for the year was submitted. Some 2½ miles of extra feeders and 94 new consumers had been added, the total consumers now numbering 450. The public lighting now comprises 85 arc and 146 incandescent lamps. The capital expenditure amounts to £56,158, and the total income from all sources was £5,590. The total units generated amounted to 490,496, an increase of about 15 per cent. on last year's figures. The average price obtained per unit was for private lighting 4·7d., and public lighting 1·7d. There is a deficiency of £1,127 after providing for interest and sinking fund charges.

Bedford.—There were 60 applicants for the post of chief electrical engineer to the T.C., and three were selected from whom to make the appointment. They were Mr. J. K. Bock, of West Ham; Mr. R. W. L. Phillips, chief assistant at Bristol; and Mr. F. L. Todd, late assistant at Wandsworth. Mr. Bock was appointed, and appeared before the Council. He declined to sign the agreement with the Bedford Corporation without first acquainting his committee at West Ham with the fact that he had secured the position. His committee meets to-day, and the Bedford Committee will have his decision to-morrow (Saturday). The Council passed *nem. con.* a resolution thanking Mr. Hope Johnstone for the very able manner in which he had discharged his duties since the inception of the undertaking in 1894. The Council has before it a proposition to increase the charge for public lighting from 3d. to 3½d. per unit.

Blaenau Festiniog.—The T.C. has accepted the revised agreement with the Yale Electric Power Supply Company for the supply of electricity to the district.

Bury.—The T.C. has adopted a new scale of charges for motive power, as follows:—For energy up to 100 units per quarter, 3d.; from 100 to 250 units, 2¾d.; from 250 to 750 units, 2½d.; from 750 upwards per quarter, 2¼d.

Cape Town.—The *British and South African Export Gazette* says that to meet the growing demands for the electric light from the suburbs of Cape Town, the Cape Peninsular Electric Lighting Company are about laying down further and improved plant, the contract for which has been entrusted to the well-known firm of Reunert & Lenz. Mr. McMuldrow, the manager, is now in England with the object of selecting the necessary material, in the choice of which he has practically a free hand.

Colchester.—The output of electrical energy for the month of July, 1901, was 4,644 units, as compared with 2,920 in 1900; the number of consumers has nearly doubled, and the lamps connected have increased from 6,866 to 11,116.

Crieff.—The T.C. has succeeded in obtaining a prov. order for lighting the town, and is considering whether to undertake the work of installation, or to advertise for a company to do so.

Dudley.—It has been decided to make application to the L.G.B. for sanction to borrow £22,000 for additional boilers, engines, dynamos, cables, and other electrical plant at the generating station.

Dundee (Natal).—The *British and South African Export Gazette* says that the contract recently entered into between the Town Council of Dundee and Messrs. Swete & Lyster, Pietermaritzburg, for the electric lighting of the town and district has been transferred by them to a joint stock company, called the Dundee Electric Lighting and Power Company, Limited, and the erection of the plant will shortly be proceeded with. The company's rights cover a valuable coal mining district.

East Grinstead.—The U.D.C. has requested Mr. F. H. Medhurst to attend a meeting of the Council to explain his report on the electric lighting scheme. The report recommends that glow lamps be used for street lighting, and that a plant of 150 H.P. be put down, at a total cost of £12,844.

Germany.—A project to utilise the water-power of the River Isar in the generation of electrical energy is at present under consideration at Munich.

Glasgow Exhibition.—The Exhibition Buildings and the Art Galleries have been illuminated with festoons and rows of electric glow lamps, plain and coloured, in a highly effective and artistic manner, by Messrs. Claud Hamilton, Limited, of Glasgow. The scheme has required 50,000 lamps for its fulfilment, and has cost £3,500.

Halesowen.—The U.D.C. have decided to advertise for tenders for taking over the electric lighting order.

Horsham.—The Electric Light Committee has appointed Mr. W. G. Proctor, chief engineer at the Nuneaton electricity works, as engineering clerk of the electric light works.

Johannesburg.—The Municipality lately discussed the report of Mr. Cowell upon different methods of charging for electric energy. Mr. Cowell suggested that the total cost of administration charges, interest, sinking fund, and cost of maintenance should be charged to the consumption during the first 1½ hours per diem; and thereafter only the actual extra cost of generating the additional energy required for consumption after that period to those users in excess of 1½ hours. The suggestion was agreed to.

Longton.—The municipal electricity works are to be formally started very shortly.

London.—St. Pancras.—In view of the continued increase in the demand for energy, the Borough Council has been recommended by its Parliamentary Committee to apply to Parliament for powers to compulsorily acquire sites for the extension of the generating stations.

Stoke Newington.—The Borough Council has finally decided to obtain a supply of electrical energy from the Hackney Council, for the Stoke Newington side of certain streets on the boundary of the borough.

Manchester.—The Electricity Committee has resolved to raise the price of energy ½d. per unit to all consumers. This is said to be due to too rapid reduction of the charges in the past, which would have caused a loss of £5,000 during the next 12 months. The change will seriously affect the smaller manufacturers who have adopted electrical driving.

Mexfield.—The B. of T. has postponed the revocation of the D.C.'s prov. order for a year.

Musselburgh.—Mr. Allbright, manager of the company promoting the authorised electric lighting and tramway schemes, at an interview the other day again informed the Provost and Law Committee that the delay was entirely due to the difficulty the company had in financing the scheme.

Nairn.—The T.C. has resolved to consult Bailie Mackenzie, of Edinburgh, on the subject of electric lighting.

Nelson.—On the recommendation of Mr. Fraser, the electrical engineer, the following new scale of charges has been arranged:—For lighting, up to 1,000 units, 4½d. per unit; up to 3,000, 4¼d.; up to 5,000, 4d.; up to 8,000 units, 3¾d.; over 8,000, 3½d.; over 10,000, 3d. For motive power, 2½d. It was also decided to reduce the meter rents to one-tenth of the cost of the meter.

Newbiggin.—The U.D.C. has resolved to support an application of the Northern Counties Electricity Supply Company for electric lighting powers for the district.

North Berwick.—The T.C. has reopened the question of electric lighting, on which a plebiscite was recently taken.

Suez Canal.—Mr. Consul Cameron in his report for 1900 states that the percentage of ships using the electric light in the canal was 91·2 per cent., as against 90·7 per cent. in 1899.

Partick.—The charges for the supply of electrical energy for the ensuing year have been fixed as follows:—For domestic supply, 3½d. per unit; for ordinary lighting purposes, 6d. for first hour's use of maximum demand and 1d. per unit thereafter; for churches and halls, 3d. per unit; for power, 2d. per unit. The new generating station is now rapidly approaching completion.

Rockhampton.—The report on the Rockhampton Gas and Coke Company for the half-year ended June shows that the result of the electricity supply operations for the period was a balance of £225 carried to net revenue. The report adds, "With a view to revising the present electric light system and placing the supply of current on a more satisfactory footing, new cables have been purchased in England, and certain improvements have been made at the generating station."

Rotherham.—The T.C. has resolved that application be made to the L.G.B. for sanction to the Council borrowing £12,000 for additional plant at the electric light station, and for the extension of mains and feeders during the next 12 months.

St. Andrews.—The T.C. has resolved to apply for a prov. order for electric lighting.

St. Helens.—A report has been issued by the borough electrical engineer, Mr. J. S. Highfield, to the Electrical Supply and Tramways Committee. It shows that the number of electric lamps connected up to July 31st, 1901, was 26,221, against 14,888 on July 31st, 1900. The number of units sold for lighting during July last was 11,304, compared with 6,641 in July, 1900. For tramway traction 72,399 units had been used, against 43,925 in July, 1900, and for other power, 15,016 units, against 7,082 in July of last year.

Sale.—The U.D.C. has decided to erect an electrical distributing station in connection with the supply of the electric light to the district by the Trafford Estates Electric Power and Lighting Company.

Spain.—A company has just been formed in Madrid, with a capital of £50,000, to be known as La Sociedad San Francisco, to establish and work a central electric lighting station in the town of Villarrobledo.

Sunderland.—A dispute has arisen about the disposal of the profits accruing from the municipal electrical undertaking. The Lighting Committee, as we have already noted, decided that the profits for the past half-year should be given towards the creation of a reserve fund, the need for which they contended was of paramount importance. The sum involved was about £1,300, and the Finance Committee at their last meeting were very wroth at the decision of the Lighting Committee, declaring that the sum in hand should go towards the reduction of the rates, and that the Lighting Committee having the rates to fall back upon, the extreme need to have a reserve fund does not exist. The absurdity of the position taken up by the Finance Committee needs no demonstration; it cannot be too clearly understood that a reserve fund is of the first importance to such an undertaking, which ought not to be regarded as a source of profit.

Tunbridge Wells.—A serious explosion has taken place at the electric light works of the Corporation. It was caused by the bursting of a superheater attached to a boiler, wrecking the roof of the engine house. Two men were badly scalded.

Tyneside.—The Newburn D.C., which has charge of a fairly large area on Tyneside, has been discussing the advisability of adopting the electric light for the district, and the Newcastle and District Electric Lighting Company, Limited, has offered to supply it all the year round at the rate of 1s. per week for a 16-C.P. lamp, reckoning 3,600 hours in the year. The Council was not unfavourably disposed towards the proposal, but adjourned the matter.

Wolverhampton.—The E.L. Committee has approved of a report by the electrical engineer (Mr. Shawfield), advocating the adoption of "free wiring," in order to encourage the use of electric light by small householders. The sanction of the L.G.B. is to be sought for a loan of £1,000 to cover the cost.

Worksop.—The municipal electricity works are to be opened on 17th inst.

Worthing.—The T.C. has appointed Mr. A. C. Seaton assistant electrical engineer, at a salary of £100 per annum. Application is to be made to the L.G.B. for leave to raise a further loan of £1,691 for extensions of the mains.

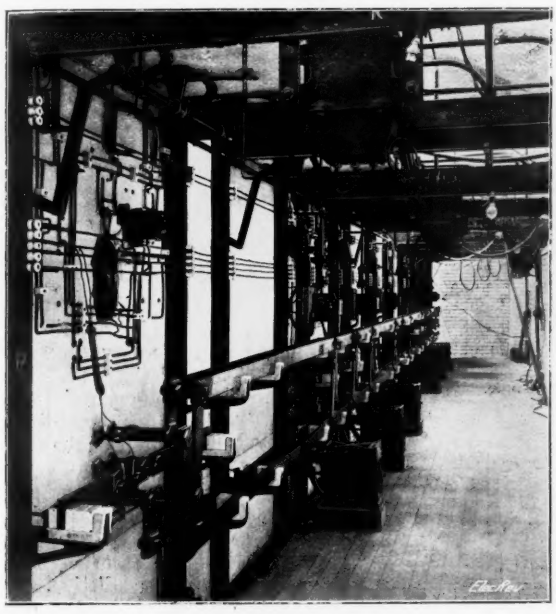
It is stated that the Marquis of Abergavenny will switch on the new electric light undertaking of the Council in about a week.

Epsom.—At the meeting of the U.D.C. on 4th inst. a letter was read from Mr. J. Clifton Robinson as to the L.U.T. application for extensions to connect up Esher, Kingston, Epsom, Leatherhead, Sutton, Carshalton, Croydon, Wimbledon, &c. The lines specifically affecting the Epsom authorities were:—(*a*) A line from Epsom to Surbiton, through Ewell and Tolworth, *vid* High Street and East Street, Epsom; and (*b*) a line to Epsom Downs from High Street, Epsom, *vid* Ashley Road. The total length would be 2 m. 1 f. 3 p., and the overhead trolley system would be used. After an animated debate, the Council decided to oppose the scheme.

GLASGOW ELECTRIC TRAMWAYS.

(*Continued from page* 395.)

The main switchboard consists of 35 panels, having a total area of over 1,500 sq. ft. There are four generator panels, four interconnecting, six exciter, one exciter voltmeter, and 20 feeder panels. The generator, interconnecting and exciter panels



Back View of Main Switchboard.

are arranged in one row, occupying practically the full width of the engine-room; the main high pressure bus bars are of bare copper tube, $1\frac{1}{4}$ in. in diameter, and of 0·44 sq. in. cross section, and are divided into five sections corresponding to the five sub-stations. These sections are normally connected together, the generators working in parallel, but if desired the generators can be run independently, each supplying one or more of the sub-stations. The interconnecting and exciter panels are interpolated between the main generator panels.

From each section of the main bus bars a set of branch bars is taken through the wall to the feeder switchboard, passing over the top of one of the five cubicles; each of these consists of four panels, arranged in pairs, back to back. Four feeders are taken from each cubicle to one of the sub-stations.

Each of the generator panels is equipped with a three-pole high pressure switch, breaking 250 amperes at 6,500 volts; three ammeters reading from 0 to 400 amperes; one voltmeter reading from 0 to 7,000 volts; two single-phase indicating wattmeters, and one three-phase integrating wattmeter. There is also a 4-point voltmeter plug receptacle for synchronising (at low pressure), a field circuit ammeter reading 0—700 amperes, a double-pole throw-over field switch, a field rheostat and pilot lamps. All the high pressure measuring instruments are of the transformer type, and no part of the high-pressure conductors or apparatus is at a less height than 10 ft. from the floor of the switchboard gallery, so that the board is absolutely safe to handle.

The main switches are of the Westinghouse standard high-pressure type, with carbon breaks, and are placed in compartments between marble slabs.

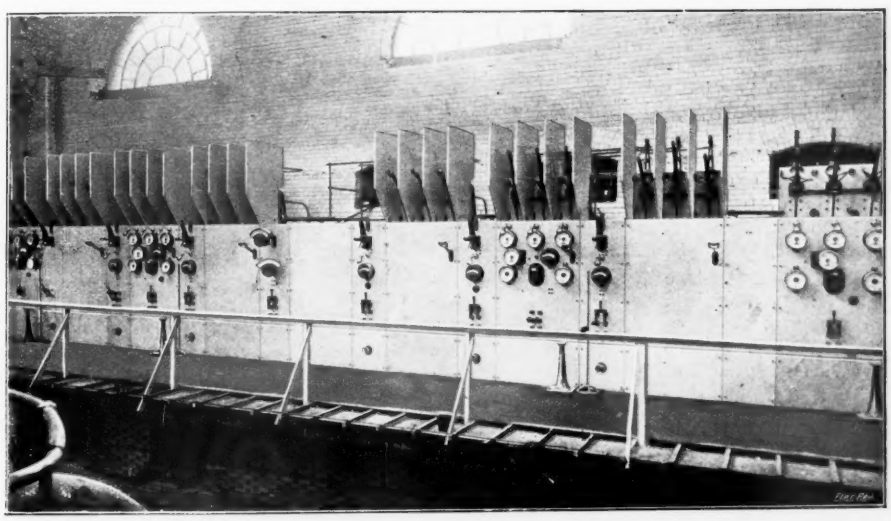
The interconnecting panels are equipped with switches of the same type, and synchronising lamps.

For the exciting and station lighting circuits two main pairs of bus bars are provided, working at 100 volts; normally the exciting current is taken from one set, and the lighting supply from the other, but the generator field switches are double-throw, so that either set of bars may be used for exciting. The exciter switches are also double-throw, so that any exciter may be coupled to either set of bars. These bars are of flat copper strip, 3 in. × $\frac{3}{4}$ in.

Each exciter panel carries a minimum current automatic cut-out, a 0—700-amperemeter, double-pole double-throw main switch and field switch, a four-point voltmeter plug receptacle, field rheostat and pilot lamp.

There is also an exciter voltmeter panel, equipped with a voltmeter which can be put on either set of bus bars, and a generator voltmeter. This panel carries in addition the main lighting switch, which connects the station lighting panel (situated below the gallery, on the auxiliary board) with either set of bus bars.

The arrangement adopted for the feeder switch gear is of special interest, and is shown in the accompanying views



Main Switchboard.

For each sub-station there is a separate group of four feeders. These are brought to panels arranged back to back in two pairs. Over the centre of the group thus formed, technically styled a "cubicle," a set of three high pressure bars is brought from one of the five sections into which the

F

main bus bars are divided. Thus each sub-station may be run quite independently of the rest.

Each of the feeder panels is equipped with a three-pole switch for 150 amperes at 6,500 volts, working in conjunction with the Westinghouse "Time Element" automatic device, which causes the switch to open for a sustained short circuit, but is unaffected by transitory overloads. The remaining apparatus consists of three 0—200 amperemeters and pilot lamps. As will be seen from our photographs, the feeder switches are isolated by marble slabs, as in the case of the main board.

The cables between the switchboard and the generators are lead covered and paper insulated; for each phase there is a separate cable, drawn into an iron pipe, of which a large number are provided in the concrete flooring. The general scheme of the connections, from the generators to the 500-volt bus bars, is shown in the diagram above; all the sub-stations are alike, except in size, and the whole of the equipment was furnished by the Westinghouse Company. Along the middle of each sub-station the rotary converters are arranged, with the high-pressure three-phase switch gear on one side, and the low-pressure direct-current switch gear on the other. The transformers are placed in the rear of the alternating current switchboard; each group of three transformers supplying one rotary converter is located in a separate fire-proof brick cell.

Each incoming feeder is controlled by a panel equipped with a three-pole 150-ampere switch, like those at the generating station, and an automatic reverse-current circuit breaker. The main bus bars are of bare copper tube, and run from end to end of the switchboard. Each of the transformer panels, of which there is one to each group of three transformers, is fitted with a high-pressure three-pole switch, three ammeters, three low-pressure single-pole switches, synchronising lamps and connections, and pilot lamps. The

Index to References.

A, 2,500-kw. generator; B, Main switch; C, Feeder switch; D, Interconnecting switch; E, Feeder switch; F, Transformer switch; G, 200-kw. transformers; H, 500-kw. rotary converter; I, Converter A.C. switch; J, Converter D.C. switch; K, Feeder cables.

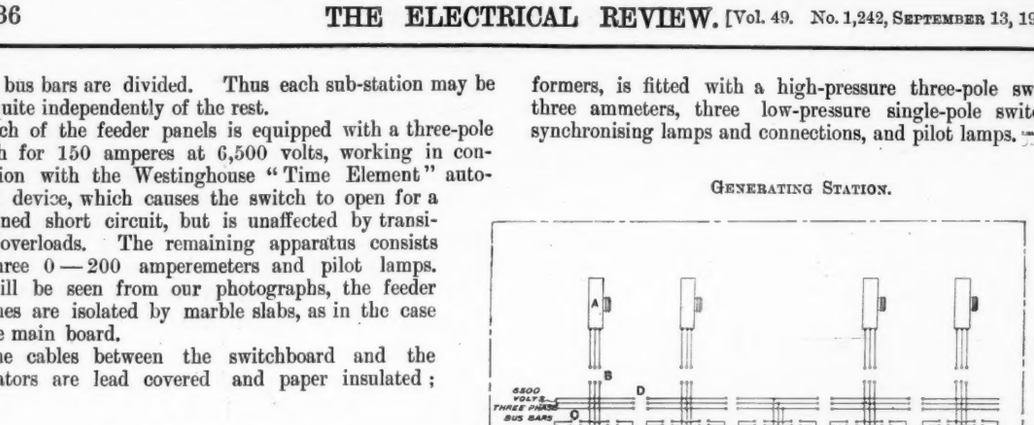
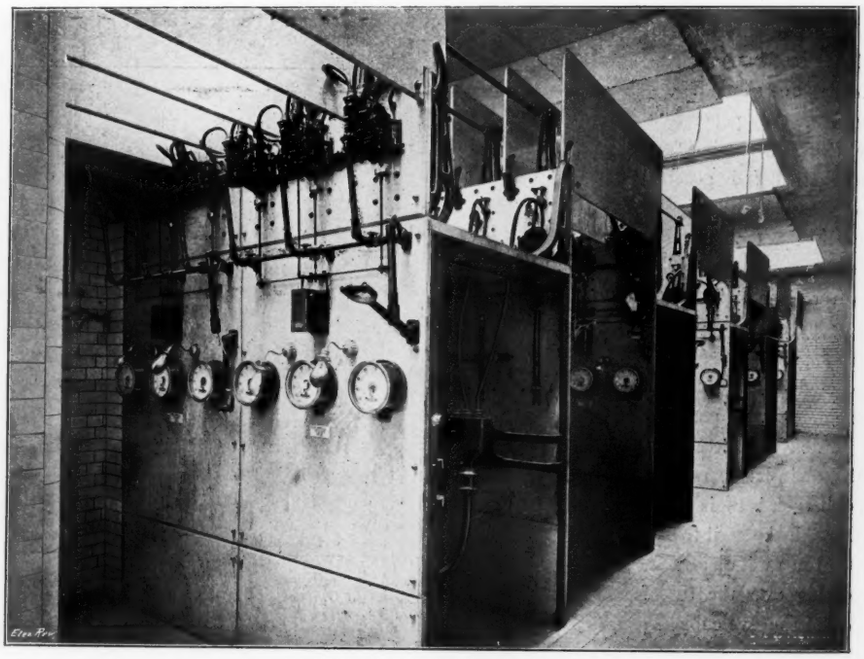


Diagram of Electrical Connections.

single-phase switches complete the connections between the slip rings of the rotary converters and the secondaries of the transformers, which are coupled to a set of three low-pressure bars, of flat copper strip, on the walls of each cell. The transformers are of the oil-cooled type, and are enclosed in corrugated sheet iron cases, with cast-iron bases and covers, so as to expose a large surface for radiation.

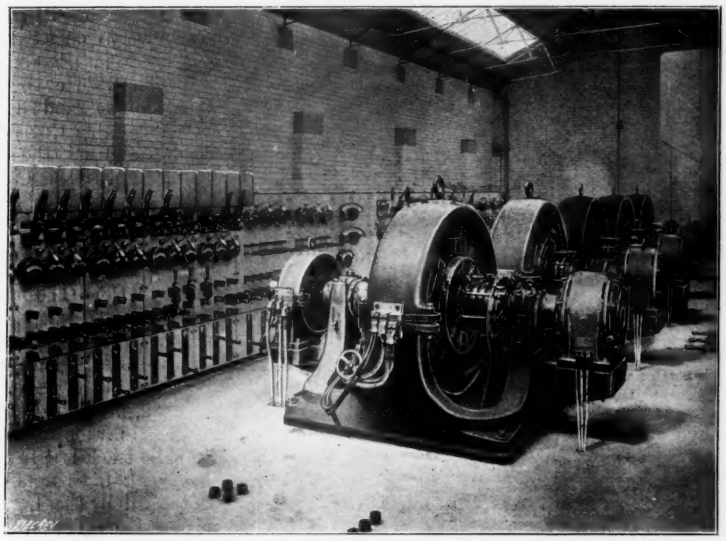
For starting the rotary converters and bringing them up to synchronism, each of them carries on an extension of the shaft a small induction motor; this is controlled by means of a small switch on the bottom of the corresponding transformer panel.



Cubicles for Feeder Switch Gear.

Each of the rotary converters is rated at 500 kw., runs at 500 revs. per minute, and is over-compounded to give 550 volts at full load. The machines are of the Westinghouse

standard type, with six field poles, drum armature, &c. Besides carrying an induction motor on one end of the shaft, each rotary bears also a booster on the other end, as shown by our photographs. The equaliser switches (for 1,200 amperes) are mounted on pillars by the side of the respective machines. The direct current switchboard is practically of the ordinary traction type. Each converter panel is fitted with two single-pole quick-break 1,200-amp. switches, a 1,200 — 2,000 - ampere automatic circuit-breaker, a main ammeter reading from 0 to 1,500 amperes, a watt-hour meter, a rheostatic starting switch for starting up the converter from the direct current bus bars, and a four - point voltmeter plug receptacle.



View of Sub-Station from the A.C. Side.

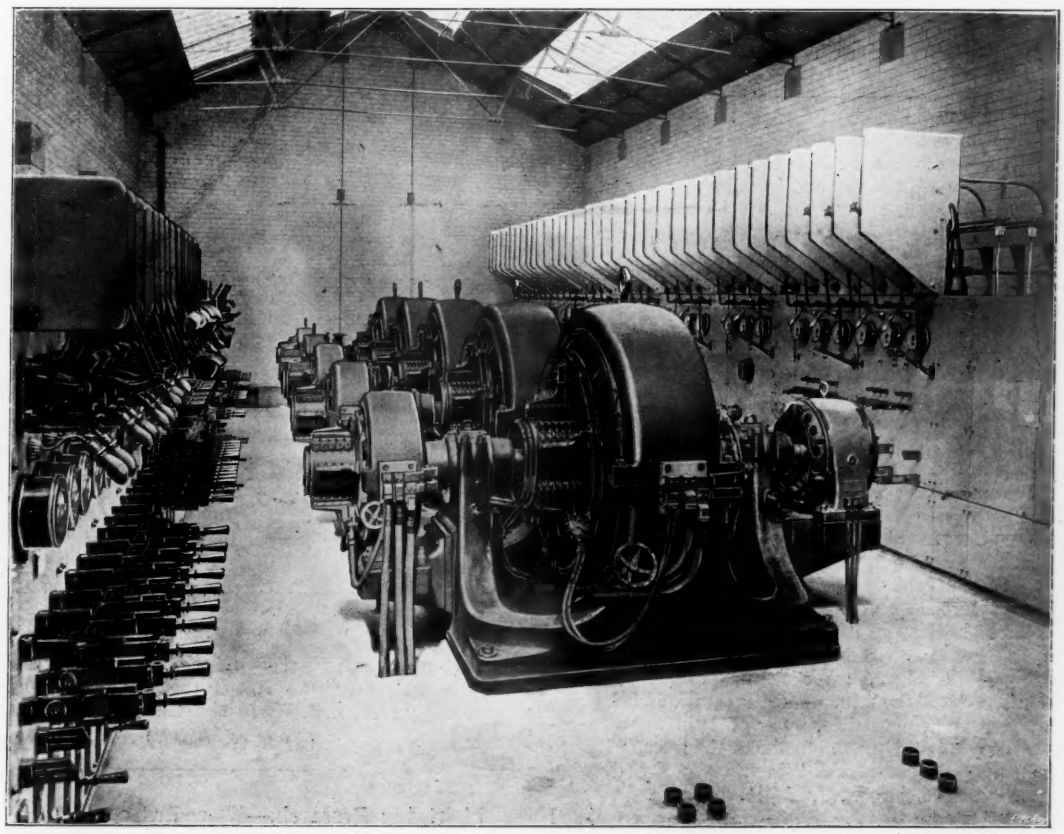
A field panel is provided for each two rotaries, carrying two centre-zero 0—60-ampere meters, two double-pole field switches, and two field rheostats. There is also a station panel, equipped with a main ammeter reading from 0 to 10,000 amperes, voltmeters for the converters and bus bars, and a watt-hour meter for 10,000 amperes at 500 volts. The main ammeters and voltmeters on both the D.C. and the A.C. boards are of the Weston illuminated dial type. At the right-hand end of the D.C. board are panels for the traction feeders and the fields of the boosters. Each feeder panel provides for three feeders, with lightning arresters and reactance coils, circuit breakers for 800—1,200 amperes, ammeters reading from 0 to 1,000, and single-pole double-throw quick-break switches for 1,000 amperes each.

The booster field panels have each three ammeters, 0—1,200, three single-pole switches for 1,200 amperes, field rheostats, and a plug board.

The booster armature panels are at the left-hand end of the board, and are provided each with three 0—1,200 - ampere meters, three 1,200-ampere single-pole switches, three voltmeter plug receptacles, and a plug board for the rail returns.

By means of the plugs on the positive feeder panels the feeders can be grouped in series with the booster fields, while the plugs on the booster armature panels enable the rail returns to be similarly coupled in series with the respective booster armatures, so as to adjust the "boost" to the desired value.

Further, the double-throw switches on the feeder panels

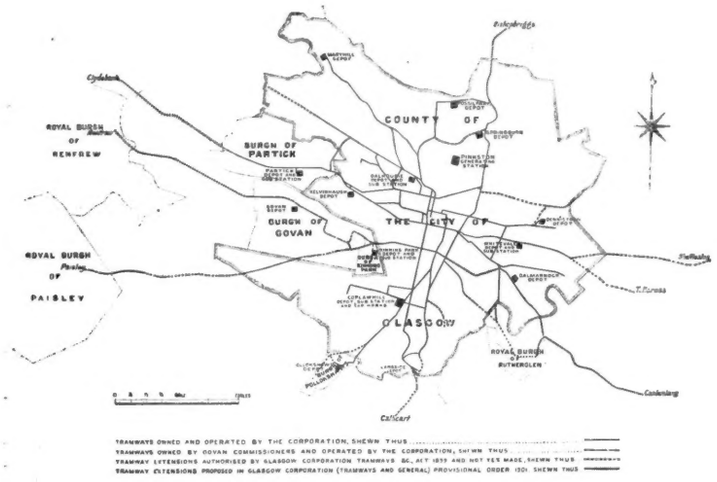


General View of Whitevale Sub-Station.

provide for passing the outgoing current either through the booster fields or direct to the feeders.

The usual Board of Trade panel is provided, fitted with Messrs. Elliott Bros'. indicating and recording instruments, and the necessary switches for pressure leads from the rails.

The high pressure bus bars are carried on double petti-


COUNTY OF
BURGH OF PARTICK
BURGH OF GOVAN
THE CITY OF
GLASGOW
ROYAL BURGH OF RENFREW
ROYAL BURGH OF PAISLEY
ROYAL BURGH OF RUTHERGLEN
Cathcart
Carntyne
TRAMWAYS OWNED AND OPERATED BY THE CORPORATION, SHEWN THUS
TRAMWAYS OWNED BY GOVAN COMMISSIONERS AND OPERATED BY THE CORPORATION, SHEWN THUS
TRAMWAY EXTENSIONS AUTHORISED BY GLASGOW CORPORATION TRAMWAYS &C., ACT 1899 AND NOT YET MADE, SHEWN THUS
TRAMWAY EXTENSIONS PROPOSED IN GLASGOW CORPORATION (TRAMWAYS AND GENERAL) PROVISIONAL ORDER 1901, SHEWN THUS

Plan of Glasgow Tramways.

coat porcelain insulators of the Post Office pattern; cast-iron clamps are fixed to the heads of the insulators to hold the bars. Joints in the latter are made by butting the ends, and rivetting and sweating a copper sleeve over the joint. Branch connections are effected by means of screwed clamps, into which the branches are rivetted and sweated.

The low pressure bus bars in the transformer cells are carried on cast-iron stools, insulated with ambroin washers and sleeves. The contractors for the special bus bar work were Messrs. Mechan & Sons, of Glasgow.

The rotary converters are started by means of the induction motors, which are constructed so as to raise the speed a little above synchronism. When the machines have been paralleled with the generators and switched in, the stators of the induction motors are cut out of circuit, and the rotors become inert, having no effect on the running except a slight increase of friction in the main bearings.

The largest sub-station is that at Dalhousie, where seven rotary converters have been installed. The other sub-stations are :—Coplawhill (5), Kinning Park (4), Partick (3), and Whitevale (5), making a total of 24 converters.

The main feeder cables between the generating and sub-stations are all three-core, with the neutral point of the system earthed. The cores are separately insulated with paper to a thickness of $\frac{1}{8}$ in., and the group is lapped over all to the same thickness. The lead sheathing is $\frac{3}{16}$ in. thick. The cables had to pass a test of 20,000 volts alternating after 24 hours' immersion in water, and were again tested after laying, with a pressure of 15,000 volts. Samples of the cable were also required to withstand 15,000 volts alternating after being bent round a drum five times the outside diameter of the cable.

The cables were drawn into cement-lined wrought-iron ducts, bedded in concrete; socketted pipes were used, in lengths of about 8 ft., 3 in. diameter inside, and laid at 5 in. centres. Where possible, a fall of 1 in 30 was provided. The total length of ducts laid amounts to 2,850,000 ft.; each was tested in position by drawing through it a hardwood mandrel, $2\frac{5}{16}$ in. diameter.

The manholes are of brickwork bedded in concrete, and are of four standard sizes :—4 ft. × 4 ft. and 6 ft. × 6 ft., with 9 in. walls, and 8 ft. × 6 ft. and 10 ft. × 10 ft., with 14 in. walls, the depth being in every case 6 ft. 6 in.

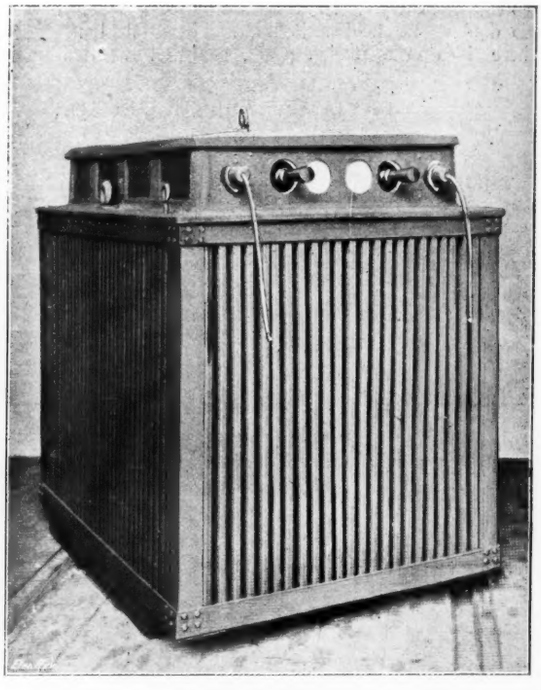
The direct current feeders and the rail returns are all single-core paper-insulated and lead-covered, the paper being $\frac{1}{8}$ in. and the lead $\frac{3}{16}$ in. thick. They were tested with 2,500 volts alternating after 24 hours' immersion in water, and 2,000 volts for 5 minutes after laying. They vary in size from 0·8 to 0·1 sq. in. cross-section.

The trolley wire feeder cables are 61/18 S.W.G., insulated with vulcanised rubber and braided, and armoured with steel wire; they were subjected to the same tests as the paper-insulated cables. The pilot wires from the rails have 2, 4, 6 or 8 cores, each 7/22 S.W.G., tested from core to core or lead sheath with 1,000 volts alternating. A very complete system of cables for telephone purposes was also laid.

The whole of the out-door cables and ducts were made and laid by the National Conduit and Cable Company, of New York; the cables inside the stations were supplied by the St. Helens Cable Company, Limited.

The track is laid with grooved girder rails weighing 98 lbs. per yard, in 60 ft. lengths, supplied by the Leeds Steel Works and Messrs. Bolckow, Vaughan and Co. The rails are 7 in. high, with a base 7 in. wide, and are laid on a concrete bed 6 in. thick. The fish-plates are 31 in. long, and are fixed with eight 1-in. bolts each. On curves the rails weigh 105 lbs. per yard. The groove is $1\frac{1}{4}$ in. wide and deep, and the gauge of the track is 4 ft. $7\frac{3}{4}$ in. The special steel work for points and crossings was supplied by the Lorain Steel Company.

Each joint in the rails is bonded with two 0000 B. & S. solid copper bonds over the fish-plates, with Daniels terminals, in



Oil-cooled Transformer.

the web of the rails, and two flexible copper bonds of the same gauge fixed in the foot of the rails. The bonds were supplied by Messrs. R. W. Blackwell & Co., Limited.

(To be concluded.)

Lightning Research.—We understand that the Lightning Research Committee of the Royal Institute of British Architects has invited the assistance of the Institution of Electrical Engineers in the collection of information bearing on the subject in question, and papers are being sent to the local honorary secretaries of the Institution abroad, in the hope that members resident in these several districts may be willing to co-operate.

ELECTRIC TRACTION NOTES.

Aberdeen.—The electric car route from Castle Street to the sea beach and the newly equipped electric line from Mannofield to Holburn Street were inspected on Saturday by Lieut.-Col. Von Donop, inspector for the Board of Trade.

Ayr.—A proposal to issue season tickets for the Corporation service of electric trams has been defeated by the Council. It was stated that the manager had communicated with several towns, and opinion was unanimously against them.

Belfast.—It seems that Belfast will not adopt electric traction for some years to come. It is believed now that the Corporation will not make any move in the matter till the lease which the tramway company holds from it expires in 1907.

Bolton.—Uncertain whether to adopt centre poles for the Deane Road tram route, the Mayor obtained the views of the Sheffield tramway manager, who pointed out the defects of the system in case of breakdowns. It has been decided not to use centre poles along Deane Road, and appearance has to give way to convenience.

Bradford.—The balance-sheet of the working of the Corporation tramways—all electrical—for the year ending March 31st last will soon be out, and will show that, after paying the sum of about £6,000 in compensation for the serious accident which occurred on the Great Horton route, and deducting the full proportion for sinking fund and interest and depreciation, there was a profit on that year's working of a little over £500.

Bristol.—The ex-tramway men continue their daily demonstrations, but with what object beyond collecting money to augment the trade union allowance it is difficult to see, for at one meeting it was stated that they did not now suggest that the new hands on the electrical cars should be discharged. A good deal of public controversy has been occasioned by the refusal of the Lord Mayor (Mr. J. C. Godwin) to place on the Council agenda a resolution of a labour member on the subject of street accidents which have lately been connected with the running of the electric cars. The action of his Lordship has been severely criticised, and at Tuesday's Council meeting, in deference to the feeling displayed, the Lord Mayor gave way, and consented to call a special meeting on the subject.

Chatham.—The laying of the rails for the Chatham and New Brompton electric tramways is proceeding very rapidly, and in many places the standards are also erected for the overhead electric system. A great deal of comment has been made upon the fact that the roadways between the metals, and on the sides, are being constructed of granite headers, and the contractors having been approached by the Gillingham District Council and others with a view of wood blocks being substituted for the stone, they have reported that the extra cost of laying wood paving would be 4s. 3d. per yard. The Committee thereupon have resolved that in the High Streets of Brompton and New Brompton wood paving shall be adopted between the tramway rails and alongside them. The resolution of the Committee was approved by the Council.

City and South London Railway.—A statement is appearing in the press to the effect that the extension of this line to Islington will be opened for traffic in November, ready for the winter service.

Crewe.—A few days ago the Light Railway Commissioners held an inquiry into the application of the British Electric Traction Company for powers for a proposed light railway. The T.C. is opposing because it wishes to carry out the scheme itself, and if the company's application should fail the Council will apply for powers next November.

Darlington.—The Council is to apply to the Light Railway Commissioners for powers to work light railways in Darlington in lieu of the present system of trams worked by the Imperial Tramways Company.

Exeter.—Last week experts were investigating tramway matters for the City Council. The B.E.T. Co. is purchasing the present lines, and the B. of T. is being asked to approve the transfer. To this the Council objects, as it has the right to purchase next year.

Glasgow.—Sheriff Fyfe has given his decision in the case of Mr. Simpson against the Corporation of Glasgow for running their cars at a speed in excess of the B. of T. regulations. The case was dismissed upon the ground of want of specification. As to the relevancy and incompetency of complainer to prosecute, the Sheriff was of opinion that complainer should have obtained the concurrence of the Public Prosecutor, in this case the Procurator Fiscal for Glasgow. On that point alone he would have dismissed it. As to want of specification, the Sheriff was of opinion the objection was well founded. It was stated that at a certain point in Pollokshields Road the cars on 28 specified dates ran at speeds varying from 13 to 22 miles an hour. That he considered unreasonably vague. Complainer should have stated the number of the car or the name of its driver, at what hour, place, and day the contravention occurred, and upon the want of definite specification of these points he dismissed the case. In criticising the case, the *Evening Times* remarks that it was "an eccentric complaint," and recommends the use of a stop watch or expert time taker, but hopes the express service of cars will still continue. In reply to a letter from the Board of Trade regarding the speed of cars on the above route, Sir Jas. Marwick, town clerk, states that it is fixed at 7·62 miles per hour.

Several minor accidents still occur on the Glasgow system. On account of one of the double bogey cars leaving the rails at Renfield Street-Vincent Street crossing, the system was completely blocked for fully an hour. The want of an efficient ganger with the breakdown gang may be said to have been the cause of the long delay. The route recently laid down under extensions of the system between Bridgeton Cross and Cumbernauld Road, was worked on the electric system for the first time this week.

Halesowen.—The Light Railways Committee last week reported that the Light Railway Commissioners had submitted the order to the Board of Trade for confirmation, but they had declined to reinstate the Bromsgrove Light Railway. The Committee recommended the Council, as soon as the order was confirmed by the Board of Trade, to advertise for offers for taking it over.

Heckmondwike.—The B.E.T. Co., in notifying the Council of its intention to commence the construction of the tramways, asked whether that body could supply energy for running the cars. The Council is agreeable, and the resident engineer has drawn up a report as to the additional plant that will be necessary.

Leeds.—The Armley and Wortley sections are the next lines to be electrically equipped. Several other new sections are also to be laid.

Leigh.—The T.C. is applying to the B. of T. for certain tramway powers. For the present the proposed branches to Plank Lane and the Hindley boundary will not be proceeded with. The South Lancashire Tramways Company's trunk line from St. Helens to Bolton will pass through Leigh from Lowton to the Atherton boundary, and the proposed branches will radiate from it, tapping populous districts.

Liverpool.—We mentioned in our last issue that an amendment moved by Councillor Utley with reference to postponing the voting of £300,000 for electric supply purposes was defeated by a large majority. At a later stage of the proceedings Alderman Petrie moved the approval of the minutes of the Tramway Committee, which contained a recommendation that a sum of £319,000 should be placed at the disposal of the Committee for tramway purposes. Mr. Utley, however, proposed as an amendment that the consideration of the recommendation be postponed until the report of the manager on the working of the tramways had been received.

Alderman Petrie, on a point of order, said the borrowing of the £319,000 had already been sanctioned by the Council, and was included in the estimates.

Mr. Utley remarked that if any of the £319,000 was for new works, it was desirable that full information as to the working of the tramways during the past year should be given.

Alderman Petrie stated that £17,000 of the £319,000 was not included in the estimates, and they could not touch any of that sum without obtaining the sanction of the Council. The remainder of the £319,000 was included in the estimates approved by the Council, and portions of the work for which it was intended had been carried out.

Mr. Utley thought the explanation was unsatisfactory. Some of the £17,000 might be for the purchase of wheels.

The Town Clerk said that the passing of the recommendation would not authorise the Tramways Committee to spend a single penny. It only placed the money at their disposal to enable the Committee at some future date to recommend the Council to expend the money for specific purposes.

The recommendation was adopted.

Though the controversy which has gone on in the local press during the last fortnight, on the working of the tramways, has aroused general interest in the district, there has not been any evidence of doubt as to the perfect safety of the electric car system on the part of the public. On the contrary, the varied expressions of opinion seem to have had the effect of booming the system. None of the many accidents which there have been since the opening of the system, not excepting the serious accident in Pembroke Place in February last, have shaken public faith in the system in the least. The use of the cars by the public has largely and steadily increased. A new "travelling public" has, in fact, been created, and for some time past this public in Liverpool has been using the cars with an evident degree of pleasant enthusiasm which, up to the present time, does not show the least sign of waning. The cry is rather for more facilities of the kind. The residents in the Edge Lane district are angry with the Liverpool Tramways Committee for delaying the construction of an electric car route along Edge Lane.

Longton.—The Electric Traction Company has informed the T.C. that it would have to reduce the service of cars between Longton and Stoke, owing to the fact that it could not come to terms with the Fenton Urban District Council for the laying of certain additional loops there.

Newport.—Mr. Parshall, the consulting engineer to the Borough Council, has presented a report upon the pending installation of electric tramways. He says the following list completes the specifications for the work included in the instructions for the tramways, excepting the lighting of the power station and car sheds:—Outside coal-handling apparatus, steam feed and exhaust piping, switchboards, cables and connections, cable ways and street

alternating after 24 hours' immersion in water, and 2,000

boxes, overhead line work (including switch pillars and connecting cables), car bodies, motor car trucks, motor car equipments, repair shop equipment. The Council have already approved of the buildings. Referring to the overhead line work, Mr. Parshall says that he has laid out this work on the span wire principle as being the most efficient. He proposes in the main streets to support the span wire from rosettes fixed to the buildings.

Perth.—The directors of the Perth and District Tramways have had under consideration the advisability of introducing electric traction, and are asking the T.C. if they will grant the right to work the tramways for 32 years if the company introduce electric traction.

Portsmouth.—Invitations are out for the opening ceremony in connection with the new electric car service of the Corporation. The date fixed is Thursday, 19th inst.

Richmond and Barnes.—At the next meeting of the T.C. a letter will be considered from the Barnes U.D.C. in reference to the latter's proposal to form a joint committee to take action in the promotion of a united scheme of local tramways. Meanwhile the London United Tramways notify their proposal for a line from Kingston to Richmond through Ham and Petersham, and the electrical conversion of the existing horse tramway between Richmond and Kew.

Salford.—It is stated that the inauguration of the new electric tram service will take place on October 1st, the first route to be opened being the Higher Broughton.

Sheffield.—Mr. A. L. C. Fell, the general manager of the Corporation Tramways, in a report on the accident to the 1,000-kw. generator at the Canal Wharf, Sheffield, stated that as the armature had then been lying in the water about 19 days, he did not think that it would be possible to dry it out and make it work satisfactorily. He was afraid that the only course to adopt would be to rewind the armature, which he estimated would take from six weeks to two months to do. If the British Thomson-Houston Company found that they could bake out the armature and make it work as it stands, he did not think it would be advisable to accept the same unless the Council had a guarantee for at least 10 years, as some weak points might develop at any time. The armature was successfully landed on Saturday.

Stockport.—On 10th inst. another electric car, laden with passengers, left the tracks when coming over Lancashire Hill. The car dashed into a bootmaker's shop and occasioned injuries to several persons and greatly damaged the shop premises.

The "Underground."—Press reports indicate that the electrification of the Metropolitan and District still stands thus:—Metropolitan swears by Ganz; District (Mr. Yerkes) will have nothing to do with it; result, deadlock. Mr. Forbes has now formally resigned the chairmanship of the District, and Mr. Perks, M.P., has been duly installed.

Wolverhampton.—Rapid progress is still being made with the reconstruction of the lines. The rails are now laid nearly the whole distance from Newbridge to the top of Tettenhall Rock. The work on the rock is well advanced. Spaces are being left all along the route for the Lorain contact boxes; but none of the boxes have yet arrived from America, where they are being made. No movement is yet being made towards putting down the "experimental" line on the Bilston Road. It is believed now that this will be abandoned, and that the test of the Lorain system will be made on the length of line from Queen Square to Tettenhall, *vid* Waterloo Road and Newhampton Road, which must soon be completed.

Yorkshire.—A conference between officials of the British Electric Traction Company and representatives of the local authorities in the Heavy Woollen District of Yorkshire was held at the Dewsbury Town Hall on Tuesday. Alderman E. Kilburn, of Dewsbury, was voted to the chair. The authorities represented were Dewsbury, Heckmondwike, Cleckheaton, Liversedge, Birkenshaw, Gomersal, Ravensthorpe, Thornhill and Bladford, and the results of the conference are expected to be most beneficial in the avoidance of complications. The company has obtained an order to lay a tramway from Dewsbury to Cleckheaton on the one hand, and from Dewsbury to Ravensthorpe and Thornhill on the other, and Tuesday's conference had been convened with a view to settling details with the local authorities. Mr. Sellon, chief engineer to the company, said they were anxious to proceed with the work as early as possible. He explained the plans, copies of which had been supplied to the authorities. He stated that the scheme was a most expensive one, due regard having been paid to efficiency. The company favoured the central trolley system, though the expense would be greater. To commence with, they proposed to have 44 cars, with sufficient double and single line to provide a five minutes' service throughout the district. If the traffic improved, they would improve the service. Mr. Sellon also said they hoped to commence work in six or eight weeks' time; in fact, as soon as the plans had been passed by the governing bodies. As the plans had only been sent out a few days prior to the conference, the representatives could not pledge their respective Councils to approve them. It was understood that the different bodies would be interviewed by officials of the company during the next few weeks.

TELEGRAPH AND TELEPHONE NOTES.

Dublin Telephones.—Municipalisation of telephones for the Dublin area is under consideration. Information is being collected from other towns.

Halifax Telephones.—The T.C. is to apply for powers for establishing a municipal telephone exchange.

Municipal Telephones.—A long letter on this subject recently appeared in the *Standard*, from "British Manufacturer." Its main object is to persuade municipalities, and those who act for them, to give preference to British made goods, "even at a small sacrifice."

Liverpool Telephones.—At the meeting of the City Council on Wednesday a resolution was to be proposed in favour of a municipal system of telephones, and to obtain from the Postmaster-General the necessary licence.

Poland Telephones.—The telephone system in the town of Warsaw has been taken over by the Russian Government which has leased it to a Swedish Company. The contract provides for the establishment of a large new exchange, and for all the overhead wire to be placed underground within a certain period.

Spanish Telephones.—The Spanish Government has lately granted a concession to Senor Conde de Rodas for the establishment and working of a telephone line between Madrid and Santander. A company is to be formed to carry through the scheme.

Stockport Telephones.—The Corporation has appointed a committee to consider the advisability of establishing a municipal telephone service for the borough area or for an enlarged area in conjunction with other local authorities. The committee has power to employ an expert if necessary.

The Telegraph Wire Export Trade.—Another very busy month has to be recorded with regard to the export trade of this country in telegraph wire and apparatus connected therewith. The returns just issued for August show that the shipments reached the large total of £900,358, as compared with only £53,140 in the preceding month and £724,212 in August last year. So far this year this branch of industry has been unusually active, the exports during the eight months ending with August last having attained a value of no less than £2,672,858, as against £2,389,228 in the corresponding period of last year and only £686,825 in the first eight months of 1899.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Para-Maranham	March 1, 1900	
Basseterre-Les Saintes	June 29, 1901	
Cadiz-Teneriffe	Aug. 6, 1901	
Bissao-Bolama	Aug. 16, 1901	
Trinidad-Demerara	Aug. 26, 1901	
Curacao-Coro	Sept. 5, 1901	
Landlines:—		
"*Via* Hanekin" on Persian territory	Feb. 24, 1900	
Pekin-Kalgan	June 14, 1900	
Maimatchin-Kalgan	June 30, 1900	
Communication with Baranquilla and Cartagena towns of Venezuela	Dec. 8, 1900	
"	Oct. 31, 1900	

Telegraphs in Persia.—The *Daily Mail* says that a Convention has been signed between the British and Persian Governments for the construction of a three-wire telegraph line from Kashan to British Baluchistan, *vid* Yezd, Kerman and Bampur, on conditions similar to those of the Convention of 1872 for a telegraph line from Teheran to Bushire.

Western Union Telegraph Company.—We have received from New York a copy of a brochure giving a sketch of the growth of the Western Union Telegraph Company, as prepared by the secretary, Mr. A. R. Brewer, and issued to stockholders in connection with the semi-centennial of the organisation of the company on April 8th last.

Wireless Telegraphy.—The Cunard Company are fitting an installation of the Marconi system of wireless telegraphy on board their Royal mail steamer *Campania*, in addition to the installation already fitted on the *Lucania*.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—September 18th. The Corporation wants tenders for surface condenser with pump. See "Official Notices" September 6th.

Batley.—September 14th. The Corporation is advertising for tenders for all materials for the permanent way of 3½ miles of electric tramway in the borough.

Blackpool.—September 21st. 20 tramway carriages for the Tramway Committee. Specification from Mr. J. Lancaster, tramways manager.

Blackpool.—Tenders for 30 arc lamps, switches, &c., for rectified current, for the Corporation. See "Official Notices" September 6th.

Bournemouth.—September 16th. The Town Council wants tenders for tramway rails, permanent way construction and rail bonding, and paving. See "Official Notices" August 23rd.

Bournemouth.—September 17th. The Town Council wants tenders for steel rails, permanent way construction on the conduit system, ploughs, &c., and paving. See "Official Notices" August 30th.

Bray.—October 3rd. Twelve months electrical supplies for the electric light works. See "Official Notices" to-day.

Brighton.—September 14th. Tenders for electric light installation for portion of the Royal Pavilion. F. J. C. May, borough engineer, Town Hall.

Doncaster.—September 14th. The Corporation invites tenders for tramway poles and overhead construction. See "Official Notices" August 30th.

Doncaster.—September 27th. Tenders for a 220-KW. high speed steam dynamo, piping, valves, &c. See "Official Notices" to-day.

Dundee.—September 14th. The T.C. invites tenders for overhead equipment for new tramway routes. See "Official Notices" August 23rd.

Egypt.—September 15th. According to the *Board of Trade Journal* the Local Committee at Fayoum have decided to instal the electric light in the town. Persons wishing to tender can obtain the conditions of contract from the Minister of Public Works at Cairo.

France.—October 1st. The French Post and Telegraph Authorities in Paris are inviting tenders for the supply of a multiple telephone table for the telephone exchange at Lille. Particulars may be obtained from, and particulars are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

France.—September 24th. The French Minister of Posts and Telegraphs in Paris is inviting tenders until the 24th inst., for the supply of 145 kilometres of submarine cable core, 35 tons of iron wire, 2½ mm. diameter, 45 tons ditto, 5 mm. diameter, 150 tons ditto, 7 mm. diameter, and 25 tons ditto, 8 mm. diameter. Tenders to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Germany.—September 20th. Tenders are being invited by the Prussian State Railway authorities in Coblentz for the supply and erection of six electrically-operated luggage lifts. Particulars may be obtained from, and tenders are to be sent to, Die Königliche Eisenbahn Direction, Coblentz.

Hammersmith.—September 13th. The B.C. wants tenders for pipework and tanks for the electricity works. See "Official Notices" September 6th.

Huddersfield.—September 30th. One set of 600-KW. alternating current generating plant for the electricity works. See "Official Notices" to-day.

Kingston-upon-Hull.—September 26th. The Corporation wants tenders for two high speed three-crank 800-I.H.P. compound engines and four Lancashire boilers. See "Official Notices" August 30th.

Kirkcaldy.—September 13th. The Corporation wants tenders for the supply and erection of overhead construction for electric tramways. See "Official Notices" August 23rd.

Kirkcaldy.—September 16th. The Corporation wants tenders for the supply and erection of arc lamp-posts, brackets, and switch-boxes. See "Official Notices" August 30th.

Leeds.—October 8th. Main switchboard to deal with output of three 1,500-KW. two-phase alternators. See "Official Notices" to-day.

Maidenhead.—September 23rd. Three 60-KW. steam dynamos, two Lancashire boilers, economiser, &c., for the Corporation electric lighting. See "Official Notices" September 6th.

Manchester.—September 14th. The Tramways Committee wants tenders for trolley wire and overhead line materials. See "Official Notices" August 30th.

Newport T.C. has resolved to invite tenders for 30 electric cars, which is considered to be a sufficient number to open the new electric tramways with.

Newport (Mon.).—October 21st. Coal handling winches, piping, switchboard, cables, cable ways, overhead construction, electric motor car, repair shop equipment for the tramways and power supply undertaking. See "Official Notices" to-day.

Poplar.—September 18th. The Borough Council wants tenders for multiple core lead-covered cables and accessories. See "Official Notices" August 30th.

Poplar.—October 1st. Electric lighting of four public libraries. See "Official Notices" to-day.

Rochdale.—October 2nd. The Electricity Committee wants tenders for feeder and distributor cables. See "Official Notices" to-day.

Russia.—September 14th. The municipal authorities of Erivan (Caucasia), are inviting tenders until September 14th, for the construction of an electric tramway, about four kilometres long, in the town. Tenders are to be sent to the municipal authorities of Erivan, whence particulars may be obtained.

Salford.—September 14th. The Health Committee wants tenders for a 55-KW. steam dynamo. See "Official Notices" August 30th.

Salford.—September 20th. Lighting the new generating station for the Corporation. See "Official Notices" September 6th.

Sheffield.—September 30th. Boilers, motors, fans, iron chimneys, &c., for the electricity department. See "Official Notices" September 6th.

Torquay.—September 13th. The E.L. Committee invites tenders for the supply of arc lamp carbons for a period of 12 months from October 1st, 1901. See "Official Notices" August 23rd.

Whitehaven.—September 16th. The Corporation wants tenders for the supply of incandescent lamps for six months. See "Official Notices" August 30th.

Willesden.—Economisers, boilers, piping and pumps, steam dynamos, battery, wiring, &c., for electricity works for the Willesden Infirmary. See "Official Notices" September 6th.

CLOSED.

Bradford.—The City Council has accepted the tender of Messrs. Witting Bros., Limited, for 100 car bodies and electrical equipments for the sum of £44,250; the tender of Messrs. Hurst, Nelson & Co., Limited, for 100 trolleys for £1,450; and the tender of the British Insulated Wire Company, Prescot, for the supply for the sum of £13,474 of cables and the other materials required in laying and fixing them in Manchester Road, Leeds Road, Sunbridge Road, Wakefield Road, and Manningham Lane.

The Corporation have also accepted the tender of the Keighley Engineering Company for 15 motors of 4½ H.P. at £28 each, with the option to purchase 15 more at same price if the first lot are satisfactory; the tender of the Phœnix Dynamo Manufacturing Company, Bradford, for 24 motors of 7 H.P. at £56 each, and 15 motors of 10 H.P. at £67 10s. each, and a 20-H.P. motor with spare armature and starter for £154 12s. 6d.; and the tender of the Lancashire Dynamo and Motor Company, Manchester, for a 15-H.P. motor for £96.

The Corporation has accepted the tender of the British Insulated Wire Company, Prescot, for the supply of two miles of 1·5 sq. in. lead-covered, paper-insulated cable for the sum of £2,920, to be used for a new lighting feeder from Valley Road works to the bottom of Manchester Road.

The Electricity Committee always gives preference to Bradford firms if possible. After accepting a tender of Sir W. G. Armstrong, Whitworth & Co. for 10-H.P. motors at £66 each, the Committee afterwards rescinded the resolution, and ordered the motors from the Phœnix Dynamo Company, Bradford, at £67 10s. As a reason for this particular transaction, the chairman said that their engineers advised them that the Bradford machine had a greater weight of metal.

Dartford.—The E.L. Committee last week reported that the Marquand Accumulator Company, Limited, of Cardiff, having intimated that they were not in a position to carry out the terms of their contract for the supply and maintenance of the storage batteries required in connection with the Council's electricity undertaking, the consulting engineer had been instructed to obtain revised tenders from the other firms (except those who were agents) who tendered in the first instance, for the supply and maintenance of such plant. Revised tenders had been received, and the Committee, in view of the great urgency of the matter, had, without waiting for the approval of the Council, accepted the lowest, *i.e.*, those of Ashmore, Benson, Pease & Co., Limited, of Stockton-on-Tees, amounting to £851 for the plant and £212 for the maintenance thereof for a period of five years, and had authorised the firm to proceed with the work.

during the next few weeks.

Dudley.—The E.L. and T. Committee have accepted the tender of Messrs. Ferranti, Limited, for £3,145 for engines; and that of the Electrical Construction Company, Limited, for £1,900 for dynamos.

Erith.—Subject to the L.G.B.'s approval, the E.L. Committee has accepted the following tenders for electrical plant:—

	£	s.	d.
Section A, boilers, &c., Spurr, Inman & Co.	1,870	0	0
„ B, pipe work, Babcock & Wilcox	921	3	0
„ C, condensing plant, Wheeler Condenser and Engineering Company	607	0	0
„ D, alternators, the International Electrical Engineering Company. Engines by Allen & Co., Bedford	3,070	0	0
„ E, switchboard, the International Electrical Engineering Company	£80	0	0
„ F, crane, Carrick & Ritchie	218	0	0
„ G, transformers, British Electrical Transformer Manufacturing Company	1,194	0	0
„ H, mains, &c., Callender's Cable and Construction Co.	7,517	0	7
„ I, arc lamps, „	254	18	0
„ K, station lighting, H. E. Keen & Co.	29	10	0
Total	£16,661	11	7

With reference for the tender for Section C, condensing plant, the engineer asks that the matter should not be finally settled until he has had an opportunity of looking further into it, as it would appear that there may be some difficulty with regard to the discharge, on account of the levels between the electricity works and the river. With respect to Section G, transformers, the tender recommended for acceptance must also be subject to the contractors giving the engineer the guarantees he desires, and failing such guarantees, the Committee recommend that the contractor's tender, in accordance with the specification, for the sum of £1,414, be accepted. With respect to Section H, mains, &c., Messrs. Callenders submitted an alternative offer for steel wire armoured cables, instead of steel tape armoured cables, for the sum of £8,306 8s. 11d., and the Committee recommend the acceptance of this alternative tender, if the Board of Trade require the cables to be protected by steel wire armouring.

Glasgow.—At last week's Council meeting it was stated that Messrs. Macartney, McElroy & Co., Limited's tender for tramway overhead equipment (extension), amounting to £32,511, was the lowest. It was stated by Bailie Stevenson that the work already done by this firm in Glasgow was anything but satisfactory, more especially at some of the turnings in the city. Mr. Paton, of the Tramways Committee, stated that the work was done in a very great hurry, that the trouble was being remedied, and that the committee recommended the acceptance of this tender. Contracts for coal amounting to 20,000 tons have been accepted for delivery at Pinkston tramway power station.

Gravesend.—Progress is being made with the Town Council's electric lighting scheme. The following tenders have been accepted:—

Boilers, Babcock & Wilcox, Limited	£3,005	0	0
Steam pipes, Messrs. Babcock & Wilcox	2,226	0	0
Engines and dynamos, the Lancashire Dynamo and Motor Company, Limited	6,245	0	0
Switchboard, &c., Messrs. Brook, Hirst & Co.	867	10	0
Cables and underground work, including maintenance for seven years, the Western Electric Company	7,229	0	0
Travelling crane, James Carrick & Sons, Limited	219	0	0
Accumulators, including maintenance for two years free (afterwards an additional payment of £80 for five years' maintenance), Veritys, Limited	1,677	0	0
Dust destructor, Messrs. Hughes & Stirling	1,250	0	0
Artesian well, Messrs. Isler & Co., Limited £310 (less 22s. for every foot under 100 ft. in depth)	310	0	0

Manchester.—We mentioned briefly last week that the contract for certain switchboards for the Stuart Street station had been placed with a German company. We now gather from the columns of a Manchester newspaper that the following firms were supplied with copies of the specification and forms of tender:—G. A. Steinthal, R. W. Blackwell & Co., Brush Electrical Engineering Company, Limited, Williamson & Joseph, Dorman & Smith, Veritys, Limited, Electrical Company, Limited, Crompton & Co., Limited, Bertram Thomas, J. G. Statter & Co., W. J. Fryer & Co., Limited, General Electric Company, Limited, S. H. Heywood, Brook, Hirst & Co., Elliott Brothers, Simpson Brothers, Cox-Walkers & Co., S. Z. de Ferranti, Limited, British Thomson-Houston Company, Limited, British Westinghouse Company, Limited, British Schuckert Company, Limited, John Fowler & Co., Limited, Heaton & Smith, F. Suter & Co., Limited, Cowans, Limited, Kelvin & Jas. White, Limited, and Siemens Brothers and Co., Limited. It seems that only seven firms quoted for the whole of the work, the tenders in these cases being:—

Electrical Company, Limited	£39,306 14 0
British Westinghouse Company	42,551 6 0
Siemens Bros. & Co., Limited	50,004 15 6
British Schuckert Company, Limited	57,200 16 3
Crompton & Co., Limited	58,928 18 0
Cowans, Limited	61,699 18 0
British Thomson-Houston	75,261 7 4

From the statement circulated at the Council meeting last week, it would appear that the Electrical Company stated in their tender that they had supplied and erected similar boards for some of the largest high tension stations on the Continent (Berlin, Rheinfelden, Magdeburg, Strassburg, &c.), where many thousands of horse-power were controlled by them with ease and with absolutely satisfactory results. A deputation from the committee, which recently visited several of the principal electrical works on the Continent, had an opportunity of inspecting the works of the Electrical Company, Limited, Oberspree, as well as electrical supply stations in Berlin, where the company had installed a considerable amount of high tension apparatus. The members of the deputation were impressed with the excellent manner in which the works were equipped, and they had every confidence in the orders being placed with the Electrical Company, both on the score of efficient machines and early delivery. The reasons given officially by the Committee for the granting of the contract to a German firm are as follows:—

(*a*) Price was the lowest.

(*b*) The apparatus they offered is of a standard type, and has been installed in all the chief three-phase stations in Germany, Austria, and elsewhere with great success. Experience has proved that the design of the whole of the switchgear is in accordance with the latest practice, and includes many details of which only time and experience in running will show the necessity.

(*c*) The English manufacturers have so far practically no experience in the type of switchboards required, and therefore had to get out new designs—the cost for which was no doubt included in their tender.

(*d*) Another reason why the price of the English manufacturers was so much higher is undoubtedly due to their having also included the cost of the patterns for this new class of work, which is a very expensive item.

It has been frequently noticed that English manufacturers do this rather than take the risk of having the expenses on this score practically wiped out by a repeat order.

(*e*) The English manufacturers appear to have been very careless in estimating for this work, as since the tenders have been opened, it has transpired that in the case of one firm a very serious mistake was made in the calculations, and this same firm now considers that they could have quoted even lower than the Electrical Company.

According to Dr. Kennedy's specification, the majority of the instruments on the switchboards are specified to be of English make, and the Electrical Company have included these in their prices.

Dr. Bishop, in laying the matter before the Council, said that the tender of the Electrical Company was by far the lowest. The next was that of the British Westinghouse Company (£42,000), but the work would have been done in America. The next two were foreign firms, and the lowest English tender was between £19,000 and £20,000 higher than the tender they had accepted. Under these circumstances the Committee had no option but to place the order abroad. The point had been raised whether the tender they had accepted was the lowest for the individual sections as well as in gross price. To this he replied in the affirmative. A well-known electrical engineer had told him that on revising his tender (which was sent in in his absence from home), he found he would have been able to do the work for £35,000. This discovery had made the engineer determined upon a thorough reorganization of his switchboard staff.

Nelson.—The E. and T. Committee has accepted tenders as follows:—

Switchboard and main cut-outs	Dorman & Smith.
Balancer and booster	Greenwood & Batley, Limited.
Iron and steel work	Edward Woods & Co., Manchester.
Iron switchboard staircase	W. Macfarlane & Co.
Incandescent lamps	Improved Electric Glow Lamp Co.
Meters	Ferranti, Limited.

Application is to be made to the B. of T. for borrowing powers (£8,700) for reconstruction and equipment of the tramways.

Yarmouth.—On the advice of the Tramways Committee the Council has accepted the following tenders for various plant necessary for tramway work:—

Poles, overhead equipment and electric bonding, British Insulated Wire Company, £5,369 14s. 6d.
Earthenware conduits, Messrs. Doulton & Co., Limited, £449 12. 11d.
Storage battery, booster and switchboard, fresh tenders to be invited, the lowest for this work being in excess of the amount allowed.
Points and crossings, Askham Bros. & Wilson, at £1,127 5s.
Cable, Telegraph Manufacturing Company, £1,993 3s. 11d., accepted subject to the proviso that they conform to the terms of the conditions of contract with respect to arbitration, failing which the tender of Messrs. Johnson & Phillips, at the sum of £2,012 18s. 6d., subject to a similar proviso, failing which the tender of the British Insulated Wire Company, at the sum of £2,041 18s. 6d., they not having in any way modified the conditions of contract.

FORTHCOMING EVENTS.

Wednesday, September 11th to 18th.—Glasgow. Annual Congress of the British Association for the Advancement of Science.

NOTES.

Electrical Engineers (R.E.) Volunteers.—The following particulars regarding the annual training of a detachment of the E.E.R.E.V., which took place this year at St. Mawes, near Falmouth, may be of interest to our readers. They were furnished to us by one of the non-commissioned officers present with the party:—

"The training commenced on August 15th, and finished on the 24th of that month, the number present being

cars, which is considered to be a sufficient number to open the new electric tramways with.

to proceed with the work.

1 officer, 1 permanent staff, and 40 non-commissioned officers and men.

"We arrived at St. Mawes Castle, which is a very old one, said to have been built in the reign of Henry VIII., about 7.30 p.m. on Thursday, the 15th, and slept there that night, the previous day having been too wet for the tents to be pitched. On the following day we turned out about 6 a.m., and commenced to pitch the tents and dig latrines, &c., which we completed about 11.30 a.m., when we assisted S.S. Lloyd, R.E., to complete the connections for the projectors at St. Antony and St. Mawes, clean the reflectors, lamps, &c., and put them in position.

"Our camp was situate close to the Castle on a small patch of land close to, and about 20 ft. above, the level of the sea, and consisted altogether of 10 tents, one for non-commissioned officer, one for a guard tent, and eight others for the men. There was a public footpath on either side of our camp, and we had to have flying sentries always on duty, night and day. There were also two cooks' orderlies and one camp orderly appointed each day.

"The work consisted of search lighting and engine driving (oil and steam). We also had some practice in rowing. S.S. Brook showed some of us over the Submarine Miner H.Q. at Falmouth, and explained the mines and various connecting boxes and firing apparatus, which was very interesting, and our Staff Sergeant Reilly, R.E., explained to others the electrical connections for firing and testing the mines, but we had no practice in submarine mining, much to everyone's regret.

"The lights were run on Monday morning, Tuesday night until about 10 o'clock, and on the following Wednesday and Thursday from 8 p.m. to 4 a.m., when we worked in two shifts of four hours each. We had to go by boat to the St. Antony, Middle Point, and Pendennis stations, viz., by the submarine miners' steamer *General Elliott*. We also had a fair amount of drill each day.

"On Friday morning we paraded for inspection by the District Engineer of the Western District, who expressed himself satisfied with our appearance.

"We had two cricket matches with the St. Mawes Club, who kindly lent us the necessary pads, bats, &c.

"On the last Friday evening we had a smoking concert at the St. Mawes Hotel. We had no lack of talent, and many of our men sang well. The coastguard gave a recitation with a rousing chorus; Mr. Cox, a sailor with a wooden leg (beating time with it) also sang, and Lance-Corporal Hardy, R.E., sang several good songs with chorus, as did also the cook's mate. The concert was voted by everyone a great success. Sergt. Charlton, who ably filled the chair, after the King's health had been drunk, proposed the health of Staff-Sergt. Reilly, R.E., who had charge of the camp, and made all the arrangements for us, much to everyone's satisfaction, and it was drunk with enthusiasm. The evening broke up with Auld Lang Syne.

"On the following day we were roused, with some difficulty, at 5 a.m., and at once proceeded to strike our camp, packing the tents and our kit bags, and left St. Mawes by the *General Elliott* by 10 a.m. for the 10.40 at Falmouth for London, leaving the camp quite clear.

"We always found the R.E.'s ready to give us information, and very much appreciated their kindness throughout, and it was agreed on all hands that this training had been one of the most successful the corps had ever had.

"Other detachments of our corps have been this year to the Isle of Wight, Milford, Plymouth, Felixstowe, Gravesend, and Sheerness for their training.

"The members of our detachment came from all parts, and four of them had been to the front."

Obituary.—We regret to learn that Mr. Ernest H. Bowyer, who was for eight years connected with Messrs. Ball Brothers & Bates, electrical engineers, of Holborn, died at Maritzburg, Natal, of consumption, on August 19th.

The death is announced, at the ripe old age of 83 years, of Mr. Richard Spelman Culley, formerly engineer-in-chief H.M. Telegraphs. The sad event occurred on 5th inst., at his residence at Weston-super-Mare.

The Light Railways and Tramways Association.—In our last issue we made a brief allusion to the dinner of this Association, which was held in Glasgow during the Engineering Congress week. The steady change that has been forced upon the electrical press by the gradual shifting of the centre of gravity from telegraph, telephone, and even electric lighting work, is evidenced by the proportion of space in our own columns that has gradually been given to traction. The old Tramway Act of 1870 had a bad influence in restraining investment and keeping back all development, and now that the Light Railways Act is soon to lapse, we may express the hope that a new and comprehensive Act may be brought in that will deal with the subject in a broad and liberal manner, so as to encourage investment. There is a great field open to the Association. The question of fuel economy, and the great difficulty in securing it with such poor load factors, is of considerable importance; hence tramways ought to be the means of vastly improving accumulators, as these, if perfected, would economise plant all round. Then there is the lack of a proper and uniform system of statistics, more in line with railway statistics, for electrical tramways, both as regards passengers, motive power, and the mileage of details, these including axles, car wheels, trolley wheels, poles, motor armatures, &c., whereby alone future design can be commercially economised. Particularly is required the car-hours run in a given time, and not merely the car-miles. Without car-hours we can know nothing of average speeds, or the influence of speed, &c., on power consumption, nor can we so well prepare new systems.

In his eloquent and impassioned after-dinner speech, Mr. Garcke, says a contemporary, "explained once more his modified but cordial approval of municipal enterprise that did not degenerate into municipal trading." Doubtless the writer knows better than we do the workings of Mr. Garcke's mind, but to an outsider it certainly appeared that the whilom deadly opponent of municipalism had become an ardent convert to its seductive influences as carried out under Glaswegian auspices. Mr. Garcke, however, is not wholly unaccustomed to sitting on the fence.

English Electrical Engineers at Buffalo.—From what we learn it seems that only a very small number of members of the Institution were able to accept the invitation to attend the convention of the American Institute at the Pan-American Exhibition, Buffalo. The Institution was not officially represented, although the French sent official delegates. The total number of Englishmen who put in an appearance was seven, but during the entire convention, and in fact outside its limits as well, this select party was most hospitably received, and was accorded the same measure of liberality and the same privileges as the French and other foreign delegates. The English visitors were Mr. Cottam, the chief electrical engineer at Hampstead; Mr. Cooper, of the Reading electrical undertaking; Mr. Denham, electrical engineer to the Cape Government Railways; Mr. A. H. Pott (of Messrs. Preece & Cardew); Messrs. Sawers and McNaught, from the India-Rubber and Gutta-Percha Works at Silvertown; and the Bromley electricity works engineer.

Magnetic Survey of India.—The *Times* states that following their acceptance of the proposal of the British Association for an ethnographic survey of India, Lord Curzon's Government have adopted the suggestion of the Royal Society for the carrying out of a magnetic survey. Sunspots are believed to be closely connected with the perturbations of the magnetic needle, and as Sir Norman Lockyer's inquiries are held by him to establish some association between sunspots and Indian droughts, the survey, besides subserving the cause of science, may prove to be of some practical utility from the administrative standpoint. The existing magnetic observatories at Bombay and Calcutta being inadequate as base stations for the vast area the survey will cover, similar observatories are in course of construction at Dehra Dun, below the Himalayas, at Kodaikanal, in the Madras Presidency, and at Rangoon. The Dehra Dun observatory will be under the supervision of Colonel Gore, R.E., the Surveyor-General of the

Indian Survey (whose headquarters are located there); but the other four will be in charge of Mr. John Eliot, the meteorological reporter to the Government. The Survey and Meteorological Departments will, in fact, be jointly responsible for the investigations. The field observations will be carried out by six or seven detachments of the Survey Department, and these will be controlled by Captain Fraser, R.E., who has recently been arranging in England for the purchase of the necessary instruments. Scinde and the Punjab will first be taken in hand; and, as the country is now intersected with railways in all directions, enabling field detachments to quickly cover the distances from one observing station to another, it is anticipated that five years will suffice to complete the field work of the preliminary magnetic survey.

Some American Personal Notes.—The last issue of the *Electrical World* contains a batch of personal items which show how largely this country looms before the American electrical man at the present moment. We reproduce some of these interesting announcements:—

President C. A. Coffin, of the General Electric Company, has sailed again for England.

Mr. C. O. Baker, Jun., has just returned to the city, after a prolonged absence, and is well and hearty, but quite reticent about his foreign travels.

Mr. George Westinghouse returned from England last week, having, it is said, transacted some very important business while abroad.

Mr. Campbell Scott, the secretary and general manager of the C. & C. Electric Company, of New York, sailed for England on the *Oceanic* on Aug. 21st, to be gone about three or four weeks on business for his company.

Mr. A. J. J. Pfeiffer, until recently with the Compania Thomson-Houston della Mediterranea, of Milan, Italy, has completed the third-rail, high speed, electric traction work on the old steam road, Milan-Gallarate-Varese-Porto Ceriso, which he went to Milan to study and execute some two years ago. He has now severed his connection with that company, and has gone to London to identify himself with the J. G. White & Co. interests there. In this country Mr. Pfeiffer was connected with the General Electric Company.

Personal.—Mr. Herbert W. Watts, engineer and manager of the Alderley and Wilmslow Electric Supply, Limited, has been appointed as resident engineer to the Weybridge Electricity Works. He takes up his new post at the end of this month to superintend the erection of the works. Mr. Cuthbert W. Bentley becomes resident engineer at Alderley Edge.

On Thursday night last week the Italian Science Society presented Mr. Marconi with its gold medal, in recognition of his wireless telegraph work. The presentation took place in London.

The term of office of Mr. Hope-Johnstone, the retiring electrical engineer to the Bedford Corporation, expired on Monday, the 9th inst. On the preceding Saturday he was presented by Mr. Barkham, the chief assistant, on behalf of the staff and employés, with a handsome travelling dressing case and an illuminated address.

Mr. W. J. Charlton, who for 15½ years has acted as deputy town clerk and borough accountant of Jarrow, has accepted the position of secretary of the Durham County Electric Supply and Power Company, Limited.

Mr. F. H. Chaplin has handed in his resignation of the appointment of borough electrical engineer under the Southampton Corporation. The Electricity Committee recommends the Council to accept the resignation, and to advertise for applications for the appointment, at a salary of £500 per annum.

Mr. R. H. Rinder, superintendent of electric tramway construction to the Birkenhead Corporation, has been appointed to a similar position under the South Lancashire Electric Traction and Power Company.

Fatalities.—It is reported that two men have met their deaths at Palmer's Works, Jarrow-on-Tyne, as the result of electric shocks.

Electrical Progress in the Straits Settlements.—From a letter which has recently been sent to us by a correspondent at Singapore, we learn that the largest of the several isolated installations in that town is owned and maintained by the Dock Company. It consists of some 130 open Brush arc lamps supplied from Brush series machines, and there is one 50 KW. "monocyclic" alternator for incandescent lighting. This plant, with one other for hotel lighting, was supplied and erected by the local branch of an American firm, and, with all its accessories, is wholly of American manufacture. The remaining installations aggregate 140 KW. capacity, and Mr. G. E. V. Thomas is responsible for their maintenance. The principal is owned by the Government, and lights Government House and other official residences. This plant dates as far back as 1889, and consists of E.P. direct current machines belted to Davey-Paxman compound engines, with a battery to take the low load after 12 or 1 o'clock. The plant for the lighting of Tyasett Palace—the Singapore residence of the Sultan of Johore—is somewhat similar, but without cells. Mr. Thomas has at present an interesting gang of wiremen—Bengalis, Malays, Japanese and Chinamen—engaged on the re-wiring of some 1,500 lamps on this installation. It is anticipated that very shortly there will be a municipal central station laid down at Singapore, the Commissioners having recently voted £15,000 as a beginning. Messrs. Burstall & Monkhouse are to advise the Council in regard to the scheme.

Appointment Vacant.—A chief clerk at £130 per annum is wanted for the Battersea electricity works. See "Official Notices" to-day.

The Electrical Engineer Volunteers.—Among those whom Lord Roberts specially mentions in his last dispatch as having rendered special and meritorious service in South Africa are the following:—

The Electrical Engineers:—

Lieut.-Col. R. E. B. Crompton, Capt. A. Bain, Sgt. W. S. Entwhistle, Sapper R. W. Holliday, Sapper J. Rook.

NEW COMPANIES REGISTERED.

British Arc Carbons Manufacturing Company, Limited (71,268).—This company was registered on September 2nd, with a capital of £6,000 in £1 shares, to manufacture carbons, carbon rods and candles for electric arc lights, filaments for incandescent lamps, carbon plates, batteries, cells, accumulators, and other articles for general and special electrical purposes. The first subscribers (each with one share) are:—T. Bass, 170, Beaumont Road, Leyton, miner; W. Warwick, 36, Bark Place, Orme Square, W.; T. L. Hughes, 27—8, King William Street, E.C., land agent; H. V. Banmann, 96, Clarendon Road, Holland Park, W., mining accountant; J. Wright, 15, Algernon Road, Lewisham, S.E., accontmant; George H. Acorns, 54, Palmerston Road, Finsbury Park, N., clerk; and H. B. Neal, 152, Capel Road, Forest Gate, clerk. The first directors are C. Tomlinson and J. Bailey. Registered office, 11, Pancras Lane, Queen Street, E.C.

Pioneer Gas, Electric Light and Power Company of South Africa, Limited (71,290).—This company was registered on September 4th, with a capital of £2,000 in £1 shares, to acquire and deal with any rights, concessions, or contracts for generating, supplying, distributing and employing electricity, galvanism, magnetism, electric, gas, incandescent or other light, and electric, hydraulic, steam and other power in the Cape of Good Hope, the Orange River Colony, the Transvaal and elsewhere in South Africa or otherwise, and to carry on the business of gas, light, and power suppliers, electricians, electrical and general engineers, suppliers of electricity, manufacturers of electrical apparatus, &c. The first subscribers are:—J. A. Kelman, New Broad Street House, E.C., solicitor, Supreme Courts of Scotland, with 500 shares; C. S. Kelman, 27—8, New Broad Street Avenue, E.C., contractor, with 500 shares; J. A. Kelman, jnr., 60, Springdale Road, Stoke Newington, N., engineer, with one share; E. Kelman, 51, Highbury New Park, N., student, with one share; D. E. Kelman, 63, Grosvenor Road, Canonbury, N., merchant, with one share; R. W. Blackburn, Elm Villa, 39, Little Ilford Lane, Manor Park, Essex, shipping clerk, with one share; and G. C. Eedes, 8, Isledon Road, Finsbury Park, N., clerk, with one share. No initial public issue. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, 50 shares.

New Imperial Electric Lamp, Limited (71,288).—This company was registered on September 4th, with a capital of £3,000 in £1 shares, to carry on the business of manufacturers and importers of and dealers in electric and other lamps and apparatus connected therewith and accessories thereof, manufacturers of and dealers in dynamos, engines, motor cars, carriages, cycles, velocipedes, engines and apparatus, electrical and mechanical engineers, machinists, fitters, founders, wire drawers, tube makers, saddlers, wheelwrights, smiths, japanners, enamellers, platers, &c. The first subscribers (each with one share) are:—J. W. Britton, 19, St. Dunstan's Hill, E.C., agent; P. H. E. Döring, Calvert's Buildings, S.E., agent; F. Rayden, Calvert's Buildings, S.E., hop factor; Mrs. M. H. T. Döring, 6, Beverley Road, Anerley, S.E.; Miss A. T. M. Syvarth, 6, Beverley Road, Anerley, S.E.; Miss B. Syvarth, Monkton House, Chertsey; and G. G. Y. Syvarth, Calvert's Buildings, S.E., agent. No initial public issue. Registered without articles of association. Registered office, Calvert's Buildings, 52, Borough High Street, S.E.

Wilson Hartnell & Co., Limited (71,302).—This company was registered on September 5th, with a capital of £20,000 in £1 shares, to adopt an agreement with Wilson Hartnell for the acquisition of the business of an electrical, general, and consulting engineer, now carried on by him at Volt Works, Kirkstall Road, Leeds, and to carry on the business of engineers, iron, steel and brassfounders, boiler makers, wiredrawers, iron and steel cable makers, metal workers, makers of dynamos and electrical plant, builders of locomotives and rolling stock of all kinds, &c. The first subscribers (each with one share) are:—W. Hartnell, Volt Works, Kirkstall Road, Leeds, engineer; H. W. Heston, 42, Sholebroke Road Avenue, Leeds, engineer; C. Todd, 65, Highbury Terrace, Leeds, cashier; Mrs. G. M. T. Hartnell, Aysgarth, Roundhay, Leeds; M. Lee, 17, East Parade, Leeds, chartered accountant; W. S. Harrison, 4, East Parade, Leeds, solicitor; and R. L. Alkin, Hartshill Grange, Atherstone, Warwickshire, engineer. Minimum cash subscription, £3,000. The number of directors is not to be less than three nor more than seven; the first are Wilson Hartnell and such others as may be elected by the subscribers; qualification, £100; remuneration as fixed by the company. Registered office, Volt Works, Kirkstall Road, Leeds, Yorkshire.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Edison & Swan United Electric Light Company, Limited (18,984).—This company's annual return was filed on August 24th, when 117,400 "A" and 23,564 "B" shares were taken up out of a nominal capital of £1,000,000 in 150,000 "A" and 50,000 "B" shares of £5 each. 10s. per share has been called up on 89,261 "A" shares, resulting in the receipt of £44,630 10s. £456,667 10s. is considered as paid, being £203,515 on 17,139 "A" and 23,564 "B" shares, considered as fully paid, and £253,152 10s. on 89,261 shares accredited with £2 10s. paid and 10,000 credited with £3 paid. Mortgages and charges, £444,023.

Electric and General Investment Company, Limited (31,506).—This company's annual return was filed on August 7th, when the entire capital of £200,000 in 20,000 ordinary, 100 founders', and 19,900 preference shares of £5 each, had been taken up. £1 per share has been called up on the ordinary, and £5 per share on the founders' and preference shares, resulting in the receipt of £120,000. No mortgages or charges.

Metropolitan Electric Supply Company, Limited.—Particulars of registered mortgages and charges:—Date of creation of charge: July 30th, 1901. Amount secured: unlimited, but stamped to cover an advance of £50,000. Date of resolution creating charge: July 30th, 1901. Property charged: the company's undertaking and all its property, present and future, including its uncalled capital, subject only to the existing charges to secure certain debenture stock. Mortgagees or persons entitled to charge: London Joint Stock Bank, Limited, London.

NOTE.—The last return, made up to March 19th, 1901, gives the total amount of indebtedness in respect of mortgages and charges at that date as £470,000.

Hillgrove and Armidale Electrical Corporation, Limited.—Particulars of registered mortgages and charges:—Date of covering deed by which security is created or defined, January 30th, 1901; total amount secured by series of debentures, £12,000; date of resolution creating series of debentures, January 30th, 1901; property charged, the leasehold land of the company in the parish of Metz, in the county of Sandon, New South Wales; a private Act of the Parliament of New South Wales, entitled the Hillgrove and Armidale Water-power Electric Act; and all other assets for the time being of the company, including uncalled capital. Trustees for debenture holders:—George F. Fry, 46, London Road, Dover, and Lieut.-Col. Edwin C. Bensley, of 127, Fellows Road, Hampstead, N.W. Date of present issue, January 30th, 1901; amount of present issue, £8,000 (80 debentures of £100 each); amount previously issued of same series, *nil*.

SUPPLY STATION ACCOUNTS.

South Shields Corporation Electricity Accounts.

As we anticipated in September last, the accounts for 1900 of the Corporation of South Shields show a profit for the first time, marking in a satisfactory manner the last year of the management of Mr. J. A. Jeckell, who has now taken up the control of the destinies of the Coventry works. The progress made in the last four years has been encouraging, as is best shown by such figures as these:—

	Units generated.	Units sold. Private.	Public lamps.	Maximum load.	No. of arc lamps	Gross profit.	Net profit.
1897	153,338	82,172	41,729	127 KW.	31	£144 —	£1,676
1898	391,637	200,808	107,300	323 KW.	63	£2,149 —	£882
1899	634,464	394,039	107,800	500 KW.	63	£4,231 —	£73
1900	944,629	573,094	182,732	705 KW.	191	£6,276 +	£1,024

Considerable extensions have been made, which have taken up nearly £40,000 extra capital, the total expenditure now reaching over £128,000.

GENERAL STATEMENT.

	1899.	1900.	Inc.
Total capital expenditure ...	°88,687	£128,488	£39,801
Number of units sold	1,839	755,826	253,987
Maximum load in KW.	500	705	205
Gross revenue	£. °3	£12,191	£4,008
Gross expenditure	£3,[illegible]	£5,915	£1,963
Gross profit	£4,231	£6,276	£2,045
Average price per unit sold ...	3·72d.	3·70d.	—·02d

The gross revenue has increased by no less than £4,000 at a rate per unit which remains practically unaltered. £250 in the "sundries" item is covered by compensation received from a firm of contractors for delay.

REVENUE STATEMENT.

	1899. Gross	Per unit.	1900. Gross.	Per unit.	Inc.
Sale of energy	£7,766	3·72d.	£11,658	3·70d.	—·02d.
Meter rents	203	·09d.	280	·09d.	·00d.
Supply of lamps, &c.	—	—	—	—	—
Sundry fees: rents received and compensation.	214	·01d.	253	·08d.	—·02d.
Gross revenue ...	£8,183	3·91d.	£12,191	3·87d.	—·04d

Coal shows a rise of nearly ¼d. per unit, but economies in other items more than cover this, and leave the total cost slightly better—a good result, considering that the price has been 15s. per ton for fuel against 7s., a percentage increase which Mr. Jackell believes is larger than had to be faced in most districts. The staff has been considerably augmented, or the salaries would ve indicated a larger drop in the per unit column.

COST OF PRODUCTION.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Inc.
Coal	£923	·44d.	£2,108	·67d.	+·23d.
Oil, waste, water and engine room stores.	229	·11d.	259	·08d.	—·03d.
Salaries and wages incurred in generation and distribution, and attending street lamps.	1,194	·57d.	1,518	·48d.	—·09d.
Repairs and maintenance of buildings, engines, boilers, dynamos, and renewals of public lamps.	315	·15d.	502	·16d.	+·01d.
Works costs ...	£2,661	1·27d.	£4,387	1·39d.	+·12d.
Rent, rates and taxes ..	287	·14d.	252	·08d.	—·06d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	702	·34d.	781	·25d.	—·09d.
General establishment charges, stationery and printing, law charges and insurance	302	·14d.	495	·16d.	+·02d.
Other expenses	—	—	—	—	—
Total costs ...	£3,952	1·89d.	£5,915	1·88d.	—·01d.

Owing to a revision of the financial arrangements, the sinking fund contribution has been lessened to bring the ratio of profits and repayments in line with other places. It appeared on investigation that more was being set aside than was necessary, and the undertaking benefits by the new scheme by the sum of £700 or £800 a year. Figures which show the extremes are:—

1899.	Capital.	Gross profits. Total.	% on capital.	Interest.	Depreciation and sinking fund.	% on capital.	Net profit.
South Shields	£73,692	£4,231	5·74	£2,129	£2,175	5·84	—£73
Sheffield	£391,865	£15,280	3·90	£10,368	£3,997	3·66	+£915
Belfast	£117,335	£5,936	5·05	£2,837	£976	3·24	+£2,123

To recoup the extra expenditure on fuel, the price per unit from the end of the last financial year has been increased from 7d. and 2d. to 7d. and 3d.

Profit Statement.

	1899.	1900.
Interest on loans	£2,129	£3,185
Sinking fund for repayments	2,175	2,067
Net profit carried forward	−73	1,024
Gross profit	£4,231	£6,276

CITY NOTES.

Isle of Man Tramways.

At Douglas, before the Clerk of the Rolls (Sir James Gell) last week, the petition of William Henderson Walker, liquidator of the Isle of Man Tramways and Electric Power Company, Limited, for the appointment of new trustees under the debenture trust deed, was heard. As the result of the application William Frederick Price, managing clerk to Mr. Walker, and George Ridgeway Cookson, were appointed trustees under the deed.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in, and to grant a quotation to—New General Traction Company, Limited, £200,000 5 per cent. mortgage debentures of £100 each. The Committee has ordered the under-mentioned to be quoted in the Official List:—Electric Construction Company, Limited.—Further issue of 6,390 7 per cent. cumulative preference shares of £2 each, fully paid, Nos. 25,001 to 31,390.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending Sept. 6th were £589; corresponding week last year, £487; increase, £102. Total to date, £17,828, corresponding period last year, £16,092; increase, £1,736. Miles of track open, 8¾.

Blackpool and Fleetwood Tramways.—The receipts for the week ending September 7th were £1,733 8s. 6d.; corresponding week last year, £1,595 6s. 2d.. Aggregate for half-year to date, £14,712 1s. 1d.; corresponding period last year, £14,520 9s. 8d.

Bristol Tramways and Carriage Company.—The receipts for the week ending September 6th were £3,904; corresponding period last year, £3,629; increase, £275.

Central London Railway.—The receipts for the week ending September 7th were £5,532; corresponding week last year, £4,647; increase, £885. Total receipts from July 1st (10 weeks), £59,559. Miles open, 6.

City and South London Railway.—The receipts for the week ending September 8th were £1,834; corresponding week last year, £1,487; increase, £347. Total to date, £18,394; corresponding period last year, £15,022; increase, £3,372. Miles open, 4¾.

Cork Electric Tramways.—Traffic receipts on the week ending 5th inst., £526 13s. 6d.; corresponding week 1900, £547 9s. 2d.; decrease, £20 15s. 8d. Total receipts to 5th inst., £16,760 4s. 11d.; corresponding period 1900, £14,742 18s. 7d.: increase, £2,017 6s. 4d.

Dover Corporation Tramways.—The receipts for the week ending September 7th were £290 2s. 2d.; corresponding week last year, £292 17s. 3d.; decrease, £2 15s. 1d. Total to date, £7,867 17s. 7d.; corresponding period last year, £7,416 9s. 4d.; increase, £451 8s. 3d. Miles of track open, 3. Car-miles run, 1901, 5,852; 1900, 5,152. Number of cars, 1901, 12; 1900, 11.

Dublin United Tramways Company.—The receipts for the week ending September 7th were as follows:—D.U.T. Co., electric cars, £4,205 2s. 11d.; D.S.D. Co., electric cars, £1,115 17s. 1d.; total, £5,321 0s. 0d.; corresponding period last year—D.U.T. Co., electric cars, £4,067 2s. 11d.; ditto, horse cars, £29 12s. 7d.; D.S.D. Co., electric cars, £1,133 11s. 8d.; total, £5,230 7s. 2d.; increase, £90 12s. 10d.; aggregate to date, £52,027 18s. 6d.; aggregate to date last year, £50,369 8s. 4d.; increase, £1,658 10s. 2d. The mileage worked is 45 miles electrically, as against 42 miles electrically, and two miles by horses, for the corresponding period last year.

Glasgow Corporation Tramways.—For week ending August 31st, 1901, £13,086 6s. 4d., compared with £9,269 8s. 11d. for corresponding week last year. For week ending September 7th, 1901, were £13,435 15s. 5d., compared with £9,664 9s. 1d. same period last year. This forms a new record, being £11 14s. 7d. greater than last year. Since commencement of financial at June 1st, £173,728 1s. 7d. have been drawn, compared with £133,880 11s. 4d. for corresponding period last year.

Liverpool Corporation Tramways.—Fortnight ended August 31st, 1901: Receipts £19,477, electric cars; £162, horse cars. Passengers carried, 4,202,523 by electric cars, and 28,977 by horse. Corresponding period of 1900: Receipts £13,076, electric cars; £4,327, horse cars; passengers carried, 2,663,891 by electric cars, and 795,708 horse. There are now 338 electric and six horse cars running.

Liverpool Overhead Railway.—The receipts for the week ending September 8th were £1,605; corresponding week last year, £1,792; decrease, £187. Total from July 1st to date, £17,359; corresponding period last year, £17,487; decrease £128. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The excellent reports that reached the Stock Exchange and the world concerning the satisfactory condition of the American President were all that was necessary to reassure markets after a slight spasm of weakness on Monday. The fit made itself apparent chiefly, of course, in the American railroad department, whence its effects spread to the Anglo-American telegraph section. But keen judges saw the unjustifiability of the relapse, since even had the worse come to pass, there was nothing to intrinsically affect markets. Happily, however, the danger was averted, and Yankee rails quickly recovered from their depression. The Telegraph stocks likewise advanced, although the event has left its temporary mark upon Anglo "A" stock, which is down ¼ per cent. It is certainly ridiculous that "wire" descriptions should relapse, inasmuch as the companies are bound to benefit, in any case, from the increase of business that must result from any news of importance. With the America Cup races coming on in a week or two, the Anglo-American market may possibly develop some strength, and Anglo "A" has a chance of a rise induced by speculative purchases on this account.

Investment markets pursue the even tenor of their upward way. Hyper-cautious individuals are prophesying dear money and a further fall in gilt-edged securities, but the splendid success of the New South Wales issue of four million 3 per cent. stock at 94 gave an unexpected fillip to the market, putting even a little heart of grace into the disconsolate Consol corner of Capel Court. How large is the supply of money awaiting investment is shown by the fact that applications for six million pounds' worth of the New South Wales stock were rapidly received. It is, therefore, not surprising that the market for Electrical Supply Debentures should have been swept nearly bare by buyers, and the cry is still those buyers come. Our price lists display few alterations, except in these debentures, but Electrical Supply shares are more easily bought than sold in most cases. South Londons are an exception. The provincial lighting shares are unchanged, and business in them is almost non-existent. Metropolitan Ordinary are now all alike in every respect, and are officially quoted in the same line.

The deadlock in the negotiations between the District and the Metropolitan Railway boards is having a bad effect upon the quotations for the companies' stocks. Districts are only slightly lower at 29¾, but Metropolitan Consolidated shows a point loss at 79. Stock Exchange sentiment rather favoured the attitude of the Metropolitan Company at first, but it is getting sick of the present situation, and now blames each company impartially. Central London Deferred is harder, and the other "Tube" issues have been better, but eased off again. The line is playing its passengers mysterious tricks just now, perhaps from the experiments in progress with the new motors. It is to be hoped that a settlement will quickly be arrived at, for the sake of the travelling public and stockholders. Waterloo and City is 1 per cent. down upon the cessation of last week's buying orders. City and South London descriptions show no change, and we may add that our efforts to find a market price for the lately-issued Third Preference stock are fruitless. There is no quotation for it.

British Electric Tractions are in good request, and we trust that the Stock Exchange Committee will quickly grant the quotation to the new Preference shares that the latter are now entitled to have. A deal of inconvenience has been caused by the delay, for which there is very little reason. Amongst other traction shares, Cape Electric Tramways are a good market, having improved to £2 buyers. We may whisperingly remark that a well-known British general, who has lately been studying South African affairs on their native veldt, has been a considerable buyer of Cape Trams. At 12½ Dublin United Ordinary are a little better, the Horse Show having brought along buyers. The London Motor Company is talking of a motor service between Putney and Piccadilly, the system to be inaugurated next Monday. Motor finance, as a whole, has been so bedraggled with suspicion and discredit in the past that its very name savours of failure in the Stock Exchange, and only by achieved success can motor enterprises hope for any support from Throgmorton Street, although many members of the House now possess their own automobiles, and the King's delight in his car ought certainly to encourage the industry.

National Telephone Ordinary have slipped back 2s. 6d., and business is very quiet in them once again. It needs a large amount of speculative interest nowadays to maintain the price of telephones. Western Telegraph Debentures and Debenture stock are both harder. Talk of a competitive cable line to East Africa, under German auspices, is not regarded with any degree of seriousness in the Stock Exchange. West African Debentures are steady at a shade over par, and the shares have become almost unpurchaseable. The nominal price is about £3, and before the French Government bought part of the company's cable, these shares were difficult of realisation. At half-a-sovereign Eastern Extensions are rising, and there is a small advance to record in Globe Telegraph and Trust Preference.

In the industrial list, Edison & Swan find buyers at 6s. per share. There is some inquiry afoot for India-Rubber, Gutta-Percha shares, and the price is 10s. up, at 22. Babcock & Wilcox Ordinary are 2⅞, the Preference 1⅝, while at 10½ Willans & Robinson keep equally steady.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Sept. 4th.	Closing Quotations Sept. 11th.	Business done during week ended Sept. 11th, 1901. Highest.	Lowest
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	78 — 83	78 — 83	...	...
822,700£	Anglo-American Telegraph	Stock	£3 9s.	73/6	3⅛%	53 — 55	53 — 56	55½	53
3,088,540£	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	98 —100	98 —100	99⅜	98⅜
3,088,540£	Do. do. Deferred	Stock	18s. %	£1 7s.	5s. %	10¾— 11¼	10½— 11	10 15/16	10 9/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	5 %	3½— 4	3½— 4	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	175 —185	175 —185	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	101 —103	101½	101¼
16,000	Cuba Telegraph	10	8 %	7 %	...	5 — 6	5 — 6	5⅜	5 5/16
6,000	Do. 10 % Pref.	10	10 %	...	...	13½— 14½	13½— 14½	14	13½
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000£	Do. do. 4½ % Debs.	50	...	...	...	100 —104	100 —104 %	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½— 11½	10½— 11½	...	...
104,300£	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	143 —148	143 —148	146	143
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	97 —100	97 —100	97⅜	97
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	115 —118	115 —118	117	115½
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	13¾— 14½	14 — 14½	14 5/16	14
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	115 —120	115 —120	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5½ %	...	100 —103	100 —103	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104	101 —104	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	5½%	10½— 11	10½— 11	10⅝	...
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14¾— 15¼xd	15 — 15½	15 1/16	14 15/16
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	31 — 33	30 — 32	...	...
78,000£	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	41 — 45	41 — 45	...	...
100,000£	London Platino-Brasilian Telegraph, 6 % Debs.	100	...	...	...	102 —105 xd	102 —105	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	2½%	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	⅝— 1	⅝— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3½— 4 xd	3⅝— 4⅛	3¾	3 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	12 1/16	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅝— 4⅞xd	4⅝— 4⅞	4⅝	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	95 — 98	97½	96⅝
500,000£	Do. 4 % Deb. Stock Red.	100	...	...	4 %	95 — 98	95 — 98	96½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	⅞— 1	⅞— 1	⅞	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	...	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½xd	5 — 5½	5⅝	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅝— 5¼ xd	4⅝— 5¼xd	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	...	...
171,000	West African Telegraph, 5 % Debs.	100	...	...	...	99 —102 xd	99 —102	100¼	99½
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14 — 14½	14 — 14½	14⅛	14
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	...	...	...	101 —104 xd	102 —105	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	101 —104	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	5%	...	¼— ½	¼— ½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	...	...	...	5 — 6	5 — 6	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	...	...	...	3 — 5	3 — 5	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	101 —104 xd	101 —104 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7⅞— 8¼	7⅞— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref.	5	...	...	...	8¼— 8⅜xd	8¼— 8⅜	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10 xd	9 — 10	9¼	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅝xd	5¼— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5¼— 6	5¼— 6	...	...
150,000£	Do. do. do. % Deb. Stock Red.	Stock	...	...	...	107 —110	108 —111	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	6 %	4 %	0 %	8 — 9	8 — 9	8½	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	11½— 12½	11½— 12½	...	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	120 —125 xd	121 —126	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	4 %	4 %	8 — 9 xd	8 — 9	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13 xd	12 — 13	12⅝	12½
200,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	103 —106 xd	103 —106 xd	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5⅞— 6¼	5⅞— 6¼	...	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5½— 6	5½— 6	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	104 —107	104 —107	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11 — 12	11 — 12 xd	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104 xd	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	96 —100	96 —100	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	13 — 14 xd	13 — 14	13⅝	13 11/16
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	111 —114	111 —114	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	97 —100	98 —101	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15 — 16	15 — 16 xd	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	15⅛	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½xd	...	...
150,000£	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	97 —100 xd	97 —100 xd	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2⅛	2 — 2⅛	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90 xd	80 — 90 xd	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 3	2 — 3	2¼	2⅛
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	13 %	10½%	12 — 13 xd	12 — 13	...	...

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Sept. 4th.	Closing Quotation Sept. 11th.	Business done week ended Sept. 11th, 1901. Highest	Lowest.
20,000	British Aluminium 7 % Cum. Pref.	‡ 10	...	...	...	7 — 8	7 — 8	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	89 — 93	89 — 93	...	...
45,000	British Electric Traction	10	6 %	8 %	9 %	14 — 14½	14 — 14½	14½	14⅜
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11¾ — 12¼	11¾ — 12¼xd	12 1/16	...
350,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	122 —125	122 —125	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	8 — 9	8 — 9	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5½ — 5¾	5½ — 5¾	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	...	8 %	⅞ — 1	⅞ — 1	...	...
50,000	¶ „ „ „ 6 % Cum. Pref.	£1	...	...	6 %	1 1/16 — 1 1/16	1 1/16 — 1 1/16	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1½ — 1¾	1½ — 1¾	1½	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2 — 2¼	2¼ —	2	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108	102 —105	...	...
108,710*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	99 —102 xd	99 —102	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	15 — 16	15 — 16	15	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5⅜ — 6¼	5⅜ — 6¼	...	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	110 —114	110 —114	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	...	102 —105	102 —105	104½	103
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	...	105 —108	105 —108	106¾	106
440,100*l*	Do. do. Def. do.	Stock	...	...	...	98 —101	99 —102	101	100
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	52 — 54 xd	52 — 54 xd	53	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000 ...	10	...	...	...	5½ — 5¾	5½ — 5¾	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	8 %	3½ — 3¾	3½ — 3¾xd	...	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —105 xd	100 —105	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	2½%	¼ — ⅓	¼ — ⅓	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	2½%	1½ — 2½	1½ — 2½	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	80 — 85 xd	80 — 85	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	85 — 90	85 — 90	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1½ — 2	1½ — 2	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2¼ — 3¾	2¼ — 2¾	...	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 —102 xd	98 —102 xd	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	99 —102	99 — 102	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16½ — 17½	16½ - 17½	17	...
35,000	Do. do. do. 4½ % Pref.	5	...	4½%	4½%	5½ — 6	5½ — 6	...	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21½ — 22½	22⅝	22½
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3⅜%	3¼%	7 3/16 — 7 5/16	7¼ — 7¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	12⅞ — 13	13½ — 13¾	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	... — ...	19/- to 20/-	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	38 — 42	38 — 42	40	...
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	104 —106	104 —106	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	12 %	10½ — 11½	10½ — 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000... ...	5	...	...	...	5⅜ — 6¼	5⅜ — 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	93 — 96	92 — 95	93	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 1/-—3/-
National Electric Free Wiring, 17/6 paid, ⅛—¼.
* From Birmingham Share List.
¶ From Manchester Share List.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16.
Do. do. Pref. (£10 pd.), 10⅛—10⅜.
*T. Parker, £10 (fully paid), 16½.

Bank rate of discount 3 per cent. (June 13th, 1901).

MARKET QUOTATIONS, Wednesday, September 11th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	30/-	30/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a „ „ ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£15	£15	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£22	£22	..
a Lead, Nitrate	per ton	£24	£24	..
a „ White Sugar	per ton	£31	£31	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3½d.	3½d.	..
a „ Caustic (75/80%) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	80/-	80/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a „ Crystals	per ton	£3	£3	..
Bichromate, casks ..	per lb.	2¾d.	2¾d.	..
METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b „ Wire, in ton lots	per ton	£224	£224	..
b „ Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £140	£75 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c Tube (brazed)	per lb.	10d.	10d.	..
c „ „ (solid drawn) ..	per lb.	8¼d.	8¼d.	..
c „ Wire, basis	per lb.	7¾d.	8d.	¼d. dec.
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c „ „ (solid drawn) ..	per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) ..	per ton	£82 to £83	£82 to £83	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£82 to £83	£82 to £83	..
g „ Rod	per ton	£82 to £83	£82 to £83	..
e „ (Electrolytic) Bars ..	per ton	£82	£82	..
e „ „ Sheets ..	per ton	£90	£90	..
e „ „ Rod	per ton	£84	£84	..
e „ „ H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f „ Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	6/-	..
h India-rubber, Para fine	per lb.	8/8½ to 8/9½	8/8½ to 8/9½	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants) ..	per ton	45/0½	45/4	3½d. dec.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	50/- to 52/6	50/- to 52/6	..
i „ Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£12 5 to £12 7 6	£12 to £12 2 6	5s. inc.
g „ „ Sheet	per ton	£13 5	£13 5	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9	£9	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d „ „ „ medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d „ „ „ large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/8	1/0½ to 1/8	..
p „ rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ „ strip & sheet	per lb.	From 1/8	From 1/8	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	10½d. to 1/0½	10½d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15 to £40		..
i „ „ in bars		£58	£58	..
g Tin, block	per ton	£116 10 to £117 10	£118 10 to £119 10	£2 dec.
g „ foil	per lb.	1/6	1/6	..
n „ wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£35 to £65	£35 to £65	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	..	..	..
j „ Best Flax, 6 lea.	per lb.	..	..	..
j „ Hemp, 3 ply 10 lbs. ..	per lb.	..	..	..
j „ „ Russian, 10 lbs. ..	per lb.	..	..	..
j „ Jute, 180 lbs. rove ..	per ton	..	..	..
k Zinc, Sh't. (Vielle Montagne bnd.)	per ton	£22 10	£22 10	..

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. e Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Jackson & Till. i Messrs. Boiling & Lowe.

Quotations supplied by { k Messrs. Morris Ashby, Limited m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company, Ltd.

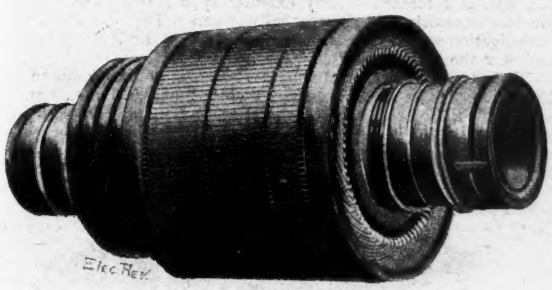
THE INTERNATIONAL ENGINEERING CONGRESS OF 1901.

HIGH SPEED RAILWAY CAR OF THE ALLGEMEINE ELECTRICITATS GESELLSCHAFT, BERLIN.

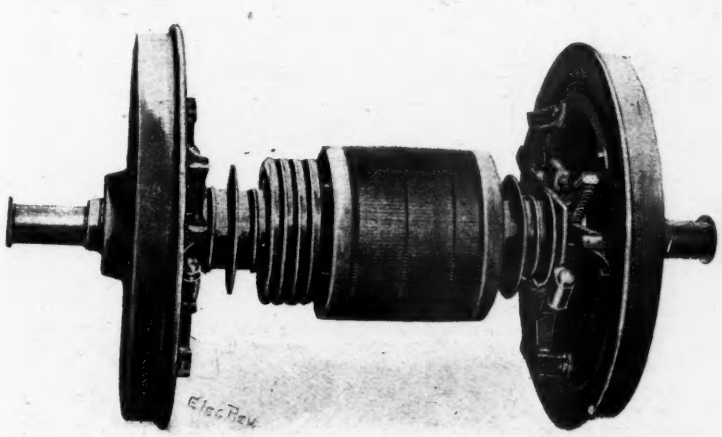
By O. Lasche (Berlin).

(*Abstract of paper read in Section IX.*)

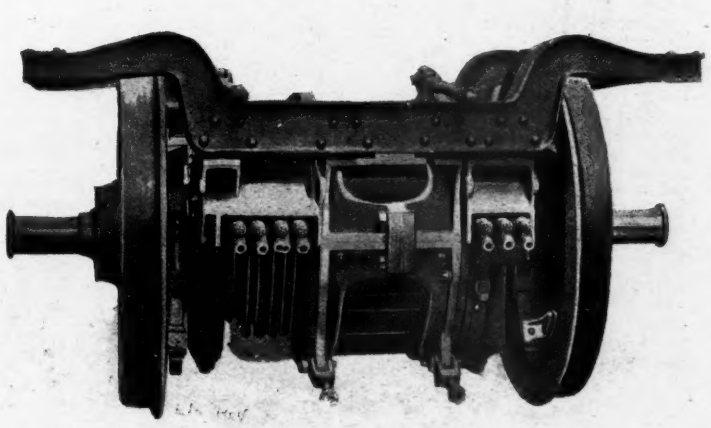
The car described in the paper is now finished, and, so far as trials and tests in the factory can give an indication of its behaviour under working conditions, has answered all expectations. It was tested at a peripheral speed of the wheels of about 56 metres per second, corresponding to a car speed of 200 to 210 km. per hour, and has been shown to the technical experts of the Studiengesellschaft für Elektrische Schnellbahnen prior to its transference to the experimental line.



Rotor with Hollow Shaft.



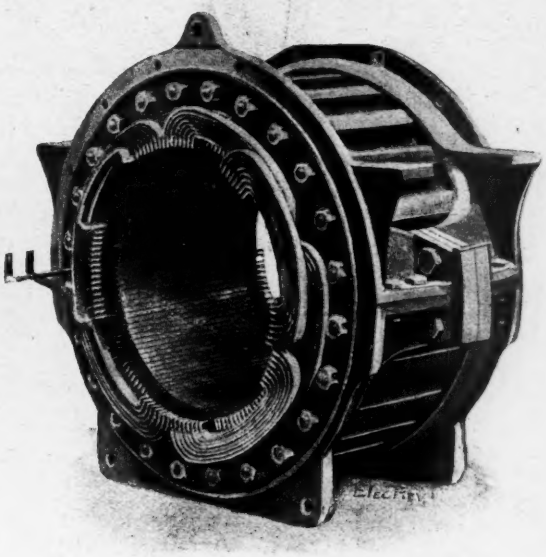
Rotor in Position, showing Spring Coupling.



End View of Bogie.

I.—Experimental Line.

The Studiengesellschaft was formed for the purpose of studying the technical and economical requirements of electric driving on long distance railways. The maximum limit of speed for the trials determined upon was 200 km. per hour. After careful consideration it was decided to use an existing military line from Berlin to Zossen, placed by the German Military Department at the disposal of the Association, as the construction of a special experimental line would have involved a serious loss of time and much extra expense. The line selected is specially suitable, as it can be used for tests of the relative advantages of different types of permanent way, track beds, rail profiles, and rail joints.



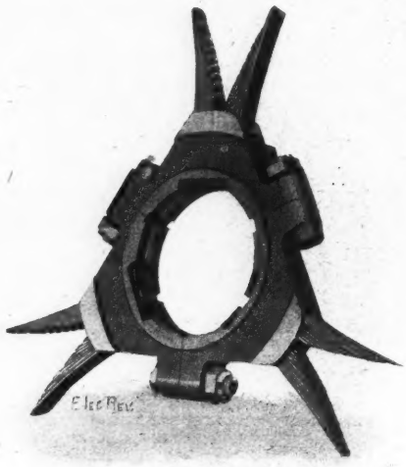
Unenclosed Stator.

The present paper relates exclusively to the construction and testing of the car, and to investigations and experiments in connection therewith. The running tests on the line will shortly commence, and will, it is hoped, form the basis for future practice in two completely different senses.

(*a*) *Attainment of a Speed of* 80 *to* 100 *km. per hour.*—In the first instance, it is necessary to ascertain what speed is attainable without necessitating alterations in the existing line. Then the extent of the diminution in the wear and tear of the track must be determined when electric cars are used, as compared with that caused by steam locomotives running at the same speed. In many cases it is probable that the electrical working of a line with single motor cars will enable existing bridges and tracks to meet the requirements of rapidly increasing traffic, whereas the use of heavier steam locomotives or longer trains would necessitate alterations. The attainment of these speeds would, in itself, be regarded as satisfactory, for distances would be covered in a reasonable time, and the public would have a more frequent train service, with shorter trains, instead of being provided with a few long trains in the day. The absence of smoke is a point in favour of electric trains. The construction of motor cars presents no difficulty, and no special alterations, either of the track or signalling arrangement, or of the ordinary working conditions, are required for an electrical service. It is not, however, necessary that electric traction should be more economical than steam traction; it will, in many cases, be sufficient to ensure its adoption to prove that the public will find it more agreeable, and that the general arrangements meet the requirements of the age.

(*b*) *Attainment of a Speed of* 200 *km. per hour.*—The experiments will be continued in the direction of determining the best working conditions for running at high speeds, the limits of which can only be ascertained by trial. For such high speeds as are here contemplated, the present systems of signalling might have to be altered, and the crossings and switches abandoned. It will be absolutely necessary to establish all high speed service on a separate track, with special

lines in either direction, exclusively for this service. Lines for local and goods traffic must be built separately. The investigations to be made relate to the motor cars, the construction of the track, and the necessity for ensuring safety.



Spring Coupling.

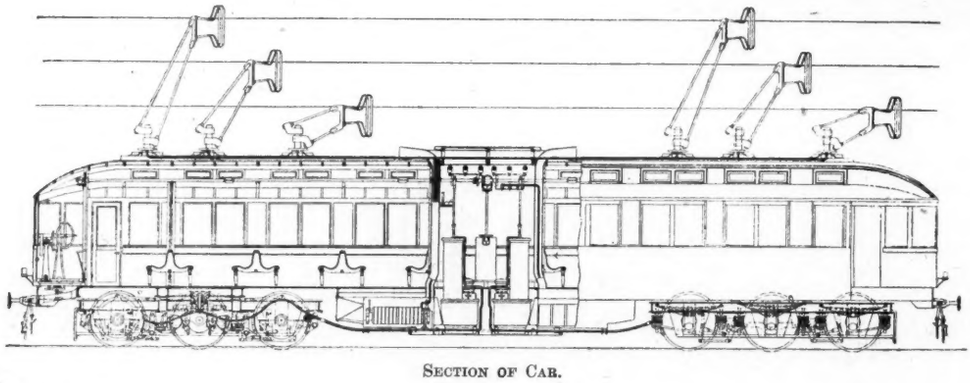
dangerous pressures. The total length of the car is about 22 m., and in cross-section it conforms to the standard structure of the German State Railway carriages. The car body is carried by two bogies, each with three axles, of which the centre is only a running axle, whilst each of the others carries a 250-H.P. motor, capable of developing a maximum of 750 H.P. The diameter of the car wheels is 1,250 mm., and the speed about 960 revolutions per minute.

III.—Investigations with Reference to the Construction of the Motor Car.

The problem before the designer was the creation of something altogether new—namely, the construction of an experimental motor car, without reference to any existing type either of low speed electric locomotive or of street railway cars. The sole aim in the investigation was the construction of a motor car to run long distances at the highest possible speed.

The weight of the electrical equipment was, in the first instance, not less than 50 tons for the required output of 3,000 H.P., but, by modifying the construction of the starting apparatus, motors, and transformers, the weight was reduced to 30 tons; but of this weight a large proportion was due to the transformers, which may possibly be dispensed with altogether hereafter.

The mechanical connection between the motors and the axles of the wheels was a matter of the greatest importance, the use of intermediate gearing being out of the question on account of the wear and tear to which it would be subjected. Although from the first the object was to obtain an elastic coupling, various designs and devices were tried, in some of which the motor was rigidly attached to the axle, whilst in others springs were introduced. The designing of a spring attachment for use at about 1,000 revolutions per minute, and with an output of 750 H.P. per motor, was a difficult task. The problem was solved by connecting the motor to the wheel by an elastic coupling, and providing an elastic suspension for the motor, the springs being arranged so as to have increasing rigidity as the load increases. The motors are accordingly



Section of Car.

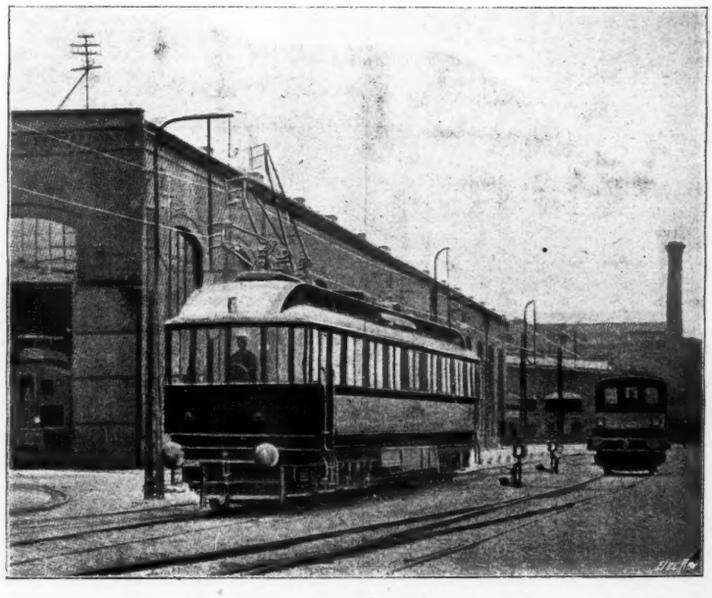
II.—The Construction of the Motor Car.

The motors are attached to the car itself, and no separate locomotive is used. Each car will accommodate about 50 passengers. The motors have in all a normal output of 1,000 H.P., and a maximum output of 3,000 H.P. The tests will show whether so much power is really necessary, and will indicate the consumption of power at different speeds, and under the influence of head or side winds.

For the working of long distance railways, the three-phase alternate current system could alone be considered. The generation and transmission of three-phase currents at from 40,000 to 50,000 volts pressure present no difficulty, but on the experimental line the pressure will be only 12,000 volts, the current being supplied from the central generating station of the Berlin Electricity Works, which is situated at a distance of 12½ km. from the commencement of the line. The length of the line is 24 km.

At present, transformers are placed on the car itself to transform the current down from 12,000 to 400 volts; but it is still undecided whether, in practice, it may not be better to use motors of medium voltage, say, of 3,000 volts, taking the current at this pressure from the line, to which it is supplied through transformers placed in transformer houses at definite intervals along the track. In this case the transformers would reduce the pressure from 50,000 to 3,000 volts. It is well known that static transformers require no attendance as compared with rotary transformers.

The car is provided with a driver's platform at either end, from which the control is effected. All parts carrying current are placed in a special apparatus compartment, which is separated from the rest of the car by a double sheet-iron partition, so that passengers and attendants cannot come into contact with current at



View of Car on Line.

mounted on a hollow shaft, of which the surface speed in the bearings is nearly 15 m. per second. Experiments and observations have been made as to the friction both at this speed and at

others up to 25 and 30 m. per second, and under very great bearing pressures.

Starting resistances for motors of 250 to 750 H.P. have already been used in practice, but the problem of arranging them in a confined space, for use in continuous regulation in connection with a power of 4 × 750 H.P., has never before been contemplated. The relative advantages of liquid and metal resistances were considered in detail. The use of the former at first seemed out of the question, whilst the latter involved the employment of a large number of contacts, brushes, connecting cables, and resistance material, making them too heavy and cumbersome.

Four motors, each with three armature circuits, give a total of 12 phases, in each of which was inserted a resistance divided into 12 steps; but in spite of this sub-division, the regulation was found to be too jerky to be satisfactory. Ultimately a liquid starting device, that could be equally well used for large winding engines, was designed. The resistance material was a solution of soda, but the apparatus had nothing in common with the ordinary liquid starting resistance.

Taking into account the fact that a speed of 200 km. per hour was contemplated, it was arranged to provide, in addition to the Westinghouse air-brake, an *electrical brake*, which could be used either in connection with, or independently of, the source of current. The brake was so designed that it could be applied either gently or powerfully at will.

Other investigations were made besides those referred to, and from the results obtained in the preliminary trials, there is every reason to hope that the motor car will meet all requirements, and enable the Association to deal with the questions relating to the running of the car on the track.

Discussion.

After remarking on the importance of this subject to the railway companies, the chairman, Mr. Langdon, called on Sir W. Preece to open the discussion.

Sir Wm. Preece admired the candour with which the experiments were described, and with which the difficulties met with were explained. He said that in Germany much experimenting and much money were bestowed on electrical problems, and that State assistance was given, also that the German Emperor took a personal interest in all the great engineering works, whereas in this country much experimenting and more money were spent in opposing big electrical schemes. He strongly advocated the three-phase system, and said that three-phase was really more continuous than a continuous current, *i.e.*, if the energy curve of a three-phase set of waves be plotted it would be found to be a straight line. In further comparing the two systems, he said that the three-phase saves 30 per cent. in weight of machinery, and by using 3,000 volts pressure on the line the cost of conductors is greatly diminished. He also said that 40 per cent. at least would be saved in capital expenditure. He remarked on the fact that the A.E.G. in their experiments had considered the comfort of passengers by trying to abolish vibration, and thought that he might convey the thanks of the whole electrical world to the A.E.G. for what they were doing.

Herr Rathenau, representing the A.E.G., said that they had made it a principle to show everything they had to show, and to conceal nothing. He referred to the fact that many competent men are opposing the change over from steam to electric locomotion because they fear competition, but the same thing happened on the introduction of electric lighting—the gas interest was opposed to it, but it had been found that in spite of the going ahead of electric lighting the gas companies had not suffered to any great extent. He thought that the steam loco. would go on for a long time yet. He thanked Sir W. Preece for his kind remarks regarding the German Emperor, and said that no one was more devoted to engineering than his Majesty. He said that they look to England for a market for the output of their works in the way of high speed railway gear and stock, so that perhaps England would be the first country to use high speed electric railways of great length, as she was the first to use steam locomotives. He said this because he thought there was small chance for them in Germany at present, owing to the railway monopolies there and the absence of competition.

Prof. S. P. Thompson wished to add his voice to that of Sir W. Preece in thanking the A.E.G. He pointed out that there is such a thing as spending money on trying the wrong experiments, for instance, the experimental railway from Earl's Court to Kensington. Everybody knew that direct current motors could be arranged to drive a train, but what people wanted to know about was the working of three-phase motors to drive a train, and this was the experiment that should have been tried. Sir Wm. Preece had told him that the experiment was really undertaken not to convince engineers that it could be done, but to convince the board of directors. The day of commutators was absolutely gone by for high-speed motors; commutators were very troublesome things. He dwelt on the importance of the introduction of liquid resistances and the consequent simplification of connections, no renewal of resistance wires, and so on. He went on to ask "Where is the English firm with a large experimenting workshop and staff such as the A.E.G. has?" and urged that unless English firms do something of this sort they must expect to be beaten.

Mr. Alex. Siemens took the opportunity of thanking Herr Rathenau for the kindness shown to the Institution in Berlin. He agreed with Sir Wm. Preece's remarks, and thought that we should discuss the general questions and leave the details to be worked out by specialists. He pointed out that the car had not yet been run on a railway but had only been tested in the shops, and a trial should give some valuable results. He said that Prof. Thompson had flogged the continuous current motor pretty well, but it still had its uses, *e.g.*, where there are many stops to be made; however, for long runs three-phase is best.

Mr. Kolben mentioned that the regulation of speed of three-phase motors by resistances was wasteful, and suggested that this could be accomplished by altering the number of poles, thus altering the speed without any waste whatever.

Mr. Gisbert Kapp remarked on the safety of high pressure systems in Germany, and said that the kind of notice board he would like to see is, "You may touch everything; it is perfectly safe," not as he had often seen in England, "Do not touch the wires; they are dangerous." He said it was very important that the drivers of high-speed cars should be rendered perfectly safe from shock. He thought Mr. Kolben's remarks *re* change of speed were not of much importance, because a high-speed railway would be built for one speed and would not be intended to run at less, and therefore the low efficiency of occasionally running at lower speeds was not of much account.

Prof. Carhart thought that the U.S. were likely to get back with interest what they had contributed to electric traction in its early days. Their companies were busy making the ordinary 500-volt cars and equipment, &c., and were not doing anything in the high-speed way, but still they felt the necessity for improvement in railways. He said that there is a line at present being built in the U.S.A. by an engineer who is going to use 11,000 volts single-phase introduced direct into the car. The same engineer has also another idea which he is going to apply—viz., to vary the speed of his car by some means and keep the motor always running at the same speed.

Prof. Carus-Wilson was struck by the immense amount of detail entered into by the paper, and mentioned that Herr Lasche had only been engaged on the work nine months. A point which vitally affects all such railways is the question of curves. High-speed cars cannot be placed on existing railways and run thereon. They would not keep the track on curves. The car under discussion was intended to be run on a straight track. He thought it was a mistake for the promoters of the Behr railway to ask Parliament for powers before they had made an experimental line. Such railways should be experimented on in detail before being put to public use.

The Chairman, in winding up, hoped that the various railway companies would see that it is to their interest to experiment with electric haulage of their trains.

THE RATING AND TESTING OF ELECTRICAL MACHINERY.

(Paper read before Section III. by Mr. Gisbert Kapp, of Berlin, September 3rd, 1901.)

Electrical engineering enters into so many industries, and has modified the conditions of modern life to so large an extent, that the sale of electrical apparatus has become an important factor in the commerce of every civilised country. To place this commerce on a safe basis, it is, however, necessary to arrive at a clear understanding as regards the properties of the different articles bought and sold. This necessity becomes the greater the more the international character of the trade in electrical apparatus is developed, and for this reason the subject of this paper may be considered as specially suited for the consideration of an international engineering congress.

At first sight it may perhaps be thought that the determination of the power, efficiency, and other qualities of electric machines is a simple matter. Electric measurements can be made with so great a degree of accuracy that two experts, if they test the same apparatus under the same working conditions independently of each other, must arrive at the same results. Hence if one expert acts for the seller and the other for the buyer of the apparatus, no difference could seemingly arise. Yet we see daily that differences arise, and the reason for this state of things is that the tests are not made under the same working conditions, and that no general understanding exists as to what shall be tested and how. As an illustration, the case of a tramway motor may be taken. The manufacturer designates it as capable of developing a certain H.P. According to his method of rating this does not mean that the motor is capable of giving off hour after hour and all day long this H.P. It only means that the motor can, in the usual way of working tramways, give off that power whenever it is required. Now, as a rule, the periods during which this full power is required form only a small fraction of the time during which the motor is in service. In such cases it would obviously be bad economy to put in a motor capable of giving off the full power permanently. Yet in other cases this may be necessary. Thus if the line contain a moderate grade many miles long, it will require larger motors than a line having very stiff but short grades, yet in the former case the maximum H.P. required is less than in the latter. We thus see that the mere statement of H.P. is not sufficient to decide the question whether the motor will be suitable for service on a line on which this H.P. is demanded of it. We have here an element of uncertainty in the rating which may cause great trouble to buyer and seller. Another source of difficulties and differences is the question of efficiency, especially in direct-coupled generators. The engine builder guarantees a certain efficiency for the steam engine, and the dynamo builder does the same for his dynamo. When the two are coupled it is easy enough to determine the combined efficiency, but it is by no means easy to find out whether each guarantee has been sepa-

rately fulfilled. Should the combined efficiency fall short of the product of the two guaranteed efficiencies, then the separate determination must be made and each expert will use a different method giving different results. Now to protect buyer and seller alike it is necessary that the method of testing should be agreed upon beforehand. If the dynamo builder knows how his machine will be tested, he can, in framing his guarantee, allow for inaccuracies of the method. The buyer gets his tenders all worked out on the same basis, and can compare them, and the expert who may be called in to test the machinery has no need to invent new methods, but will be simply requested to carry out the tests as agreed beforehand. Such rules for testing efficiency should be simple and capable of being carried out without entailing great expense or disturbance to the regular working of the plant, and they should give the efficiency with a fair degree of accuracy. Absolute accuracy can, of course, not be expected, and is not required. The important point is, that by such rules there should be established beforehand a clear understanding between buyer and seller, and that there should be no possibility of either being unfairly treated. It would be easy to multiply examples to show that a general and, if possible, international understanding as to the proper way of rating and testing electrical machinery is very desirable. As, however, on this point there will probably be no difference of opinion, the author does not propose to take up the time of the Congress by giving further examples, but he prefers to put before the Congress an account of what has recently been done in Germany in the direction of establishing standards for the rating and testing of electrical machinery.

The Association of German Electrical Engineers, of which the author has the honour of being secretary, has appointed last year a committee for investigating the question of rating and testing electrical machinery. The report of this committee was presented to the annual meeting of the Association this year and accepted by it provisionally. As is usual with rules and regulations issued by the Association, their definite adoption is only decided upon after they have been provisionally in use for a year or two, the object being to provide an opportunity for testing the rules in practical work and for altering and amending them, if the necessity arises, before final adoption, which takes place at some future annual meeting of the Association. Thus the "Standards for Rating and Testing Electrical Machinery" are still subject to revision. The committee has been reappointed with instructions to collect information as to how the standards work in practice, and to bring up a second report next year. In the Appendix is given a translation of these standards. They do not relate to all electrical apparatus, but only to that kind which is generally understood by the term machines and transformers. Thus, generators, motors, rotary converters, motor-generators, and static transformers are provided for by these standards, but not switches, switch gear, measuring instruments, fuses, automatic circuit breakers, and other apparatus. It is not intended that these standards should interfere with any special conditions which buyer and seller may agree upon; but if there are no special conditions previously arranged between the parties, then they shall both be bound by the standards of the Association.

As regards the rating of apparatus a distinction is made according to the time during which it is used. Three classes are provided, namely, for

(*a*) Intermittent use.
(*b*) Short time use.
(*c*) Continuous use.

The same piece of apparatus may be used under all three conditions, but then its rating would be different. Thus a motor which under (*c*) would be rated at 12 H.P., may be rated under (*b*) as 20 H.P., and under (*a*) as 25 H.P. The power is to be stated on the name plate, and the test is to be made according to the power stated. Thus if the motor is rated at 25 H.P. for intermittent use, it shall be tested at 25 H.P. for one hour. If the name-plate bears the inscription 20 H.P. for two hours (condition *b*) then the motor shall be tested for two hours under a load of 20 H.P. If the name plate bears the inscription 12 H.P. continuous, then the motor shall be tested with that load during 10 hours or a shorter time, if that suffices to bring it to the final temperature. In all three cases the temperature rise must remain within the limits prescribed. These are for cotton-covered wire 50° C., for paper-covered wires 60° C., and for wires insulated with mica, asbestos, &c., 80° C. For tramway motors somewhat higher limits are allowed, namely, 70°, 80°, and 100° C. respectively.

The conditions as to overload are not very rigorous. As far as generators are concerned, the capacity to give an increased output is generally limited by the prime mover, and to demand an excess of output beyond that which the prime mover can deal with would uselessly increase the cost of the electrical part of the plant. In motors, transformers and converters, somewhat larger overloads are possible, but then only momentarily, and for this reason the standards only require the overload test to be made during three minutes. The measurement of insulation resistance is not prescribed, but a breakdown test at high voltage. Also this test has been advisedly kept within reasonable limits, since a breakdown test at extremely high voltage may, even if the machine stands it, injure it just as the cold-water test of a boiler, if made under excessive pressure, may permanently weaken the plates.

The most difficult task of the committee was the framing of rules for testing efficiency. In all eight methods are given, and the maker of the apparatus has the right to specify which method shall be used in testing the efficiency. In framing the methods the committee was guided by considerations of expediency. It would, perhaps, have been possible to devise methods which, from a theoretical point of view, promise a greater degree of accuracy, but there was the danger that such very perfect methods would entail so large an expenditure of time and money, and would cause so much disturbance to the regular working of the plant, that they would not be used. Efficiency tests are ordinarily carried out only after the plant has been at work some time. Any test which causes considerable disturbance to the regular use of the plant is therefore inadmissible; and although it would, in the interest of science, be very desirable to make efficiency tests with the highest possible degree of accuracy, practical considerations must lead us to be satisfied with approximate methods which can be easily carried out. The danger that either the maker of the apparatus, or the buyer of it, may suffer through the inaccuracy of the efficiency test is provided against by the stipulation that the method under which the efficiency shall be tested must be stated in the tender. Both parties know, therefore, beforehand, what sources of error may arise, and the maker of the apparatus can frame his guarantee accordingly.

APPENDIX.

Standards for Rating and Testing Electrical Machinery, provisionally adopted by the German Association of Electrical Engineers at the meeting in Dresden on June 28th, 1901.

Definitions.

Dynamo or *Generator* is a rotatory machine for the conversion of mechanical into electrical power.
Motor is a rotatory machine for converting electrical into mechanical power.
Motor-Generator is a duplex machine consisting of motor and generator directly coupled.
Converter is a machine in which the conversion of current takes place in one armature.
The word *machine* used hereunder shall mean either of the above articles according to the context.
Armature in a machine is the part in which, by the action of a magnetic flux, electromotive forces are developed.
Transformer is an alternating current apparatus without moving parts for the conversion of electric into electric power.
Pressure in three-phase current is the pressure between any two of the three main conductors.
Ratio in transformers is the voltage ratio at no load.
Frequency is the number of complete periods per second.
Rules given for single-phase current apply also, as far as is compatible with the context, to polyphase current.

General.

§ 1. The following rules shall only apply as far as they are not changed or superseded by conditions of delivery specially agreed upon. The §§ 4, 5, 6 concerning the name-plates are, however, always to be observed. Machines or transformers without name-plates, or with name-plates not in accordance with those required, will be deemed not to comply with these standards.

Power.

§ 2. The power of all machines and transformers is to be defined according to the output. It must be stated for continuous current in kilowatts (KW.), and for alternating current in kilowatts, with the addition of the power factor. Motors are to be rated according to the output of mechanical power expressed in horse-power (H.P.).

In addition to the output there must be stated on the name-plate, or a special plate, the normal values of speed frequency, pressure and current.

§ 3. As regards the output the following working conditions are to be distinguished:—

(*a*) Intermittent use, in which periods of work and rest each lasting only a few minutes alternate (motors for cranes, hoists, tramcars, &c.).

(*b*) Short time use, in which the period of work is shorter than necessary to reach the final temperature, and the period of rest is long enough to permit the temperature to drop approximately to that of the air.

(*c*) Continuous use, in which the period of work is long enough for the final temperature to be reached.

§ 4. The power of machines and transformers for intermittent use is to be rated as that power which can be given off during one hour without the temperature rising above the limits stated below. This power is to be stated on a plate with the designation "*intermittent.*"

§ 5. The power of machines and transformers for short time use is to be rated as that power which can be given off during the working time agreed upon without the temperature rising above the limits stated below "*for . . . . hours.*"

§ 6. The power of machines and transformers for continuous use is to be rated as that power which can be given off during any length of time without the temperature rising above the limits stated below. This power is to be stated on a plate with the designation "*continuous.*"

§ 7. It is permitted to state the power for different working conditions on the same plate.

§ 8. For generators and converters for variable pressure, the plate need only contain the normal values of pressure, current and speed; the limiting values belonging together must, however, be stated in the conditions of delivery

§ 9. Machines with commutator must, if the brushes are shifted into the best positions, run at any load within the prescribed limits so far sparklessly that no treatment of the commutator with glass paper, &c., is necessary until after at least 24 hours' working.

Rise of Temperature.

§ 10. The temperature rise shall be measured at normal load as defined by the above working conditions, namely:—

1. For intermittent use after working one hour.
2. For short time use after working uninterruptedly during the time stated on the plate.
3. For continuous use.

(*a*) For machines after working 10 hours.

(*b*) For transformers after working long enough to reach the final temperature.

§ 11. If with small machines there is no doubt that the final temperature is reached under 10 hours, then the temperature rise may be measured after a correspondingly shorter working time.

§ 12. For testing the temperature rise the various casings or coverings provided for normal working must not be taken away, opened, or considerably altered. If for normal work special provision is made for cooling, this may be provided for also during the test, but it is not permitted when testing tramway motors to artificially produce a current of air as an equivalent for the motion of the car.

§ 13. As external temperature is to be taken that of the incoming current of air, or if no current is observable, the mean temperature of the surrounding air about 1 metre distant on all sides and at the level of the centre of the machine. The temperature of the air is to be measured in regular intervals during the last quarter of the time of test, and the average of all these readings is to be taken.

§ 14. If a thermometer is used, care must be taken to provide for an efficient transmission of heat between the part to be tested and the bulk of the thermometer, by using a bedding of tinfoil. To prevent radiation, the bulb and the part to be measured are to be protected by a covering of a bad conductor, such as dry wadding or waste. The reading must be taken after the mercury has ceased to rise.

§ 15. With the exception of continuous-current field coils, all parts of generators and motors are to be tested for temperature rise by means of a thermometer. As far as possible the points of maximum temperature are to be ascertained, and the readings for those points are to be considered in determining the temperature rise.

§ 16. The temperature of continuous-current field coils is to be determined from the increase of resistance. Unless the temperature coefficient is specially determined, it is to be taken as 0·04 per degree Centigrade.

§ 17. For transformers the highest temperature indicated by the thermometer at any point of the windings is to be taken. If oil be used, the temperature is measured in the upper strata of the oil.

§ 18. For ordinary cases, and if the air temperature does not exceed 35° C. (95° F.), the temperature rise of insulated conductors, commutators, and slip rings shall not exceed the following values:—

With cotton insulation	50° C. (122° F.)
With paper insulation	60° C. (140° F.)
With insulation consisting of mica, asbestos or preparations containing these materials	80° C. (176° F.)
For windings which are not in motion, these values may be exceeded by 10° C. (18° F.)	

§ 19. In tramway motors, when tested in the testing room in the workshop after one hour continuous work, the rise of temperature should not exceed the following values:—

With cotton insulation	70° C. (158° F.)
With paper insulation	80° C. (176° F.)
With insulation consisting of mica, asbestos, or preparations containing these materials	100° C. (212° F.)

§ 20. For combined insulation the lower limit must be taken.

§ 21. In windings which are permanently short-circuited, the above limits may be exceeded.

Overload.

§ 22. In practical working overload should only occur for a short time, or under such temperature conditions that the permissible temperature rise is not exceeded. With this limitation, machines and transformers must be capable of overload within the following limits:—

Generators, Motors, Converters	25 per cent. for half-an-hour, on condition that in the case of alternators the power factor is not lower than marked on the plate.
Motors, Converters, Transformers	40 per cent. during three minutes, on condition that for motors the normal pressure at the terminals is kept up.

The commutator of continuous-current machines and converters must not be injured by the test for overload to such an extent that it fails to comply with § 9.

§ 23. If tested at constant speed, the pressure of generators must be capable of being kept constant up to 15 per cent. overload, provided that when testing alternators the power factor is not kept lower than stated on the plate.

§ 24. The test is intended to prove the mechanical and electrical capacity to take an overload without regard to heating. For this reason the test is to be begun under such temperature conditions that the permissible temperature rise is thereby not exceeded.

§ 25. These regulations also apply to generators for variable pressure, in which the variation of pressure is attained by approximately proportional changes in the speed. In generators, with approximately constant speed (which work at normal pressure with a weakened field) the overload test is not to be made. The same applies to motors if they work with a weakened field.

Insulation.

§ 26. A measurement of insulation resistance is not prescribed, but a test of dielectric strength which has to be made at the makers, and with larger apparatus also on the site before starting the plant. Machines and transformers must be capable of withstanding the test for half an hour with a pressure exceeding the normal pressure by the amount stated below. The test is to be made when the apparatus is warm and shall be repeated only in exceptional cases, the object of this restriction being to avoid damage.

Machines and transformers up to 5,000 volts shall be tested for dielectric strength with double their working pressure, but not with a smaller pressure than 100 volts. If the working pressure lies between 5,000 and 10,000 volts the test pressure must exceed it by 5,000 volts. If the working pressure is above 10,000 volts the test pressure should exceed it by 50 per cent.

§ 27. The test pressure is to be applied between winding and frame, and for bodily contiguous but electrically separated windings between those windings. In the latter case the test pressure is to be determined with reference to the winding of higher pressure.

§ 28. Two electrically connected windings of different pressure are to be tested to frame with the test pressure corresponding to the winding of higher pressure.

§ 29. If machines or transformers are connected in series, then in addition to the above tests the connected windings are to be tested to frame with a test pressure determined with reference to the pressure in the whole system.

§ 30. The above regulations apply to cases where the testing current is of the same kind as the working current. If continuous current apparatus is to be tested with an alternating electromotive force, then the effective test pressure need only be 70 per cent. of the value as above defined. If, on the other hand, alternating current apparatus is to be tested with a continuous electromotive force, then the test pressure must be by 40 per cent. greater than above defined.

§ 31. If a winding is normally connected to frame the connection must be severed during the test. In this case the test pressure is determined with reference to the highest pressure which obtains normally between any point of the winding and the frame.

§ 32. Magnet coils excited from an independent source of electromotive force shall be tested with three times the normal working pressure, but not less than 100 volts.

§ 33. The winding on the secondary armature of an induction motor is to be tested with twice the working pressure occurring at starting, but not less than 100 volts. Squirrel-cage armatures need not be tested.

Efficiency.

§ 34. The efficiency is the ratio of power given out to power put in. It may be determined by direct measurement of output and input or indirectly by measurement of losses. The indirect methods are more easily carried out, less influenced by errors of observation, and for these reasons to be preferred as a rule. In stating the efficiency the method according to which it shall be or has been tested must be also stated, for which purpose a reference to the corresponding paragraph of these standards is sufficient. The efficiency must be stated for the temperature condition corresponding to normal working.

The efficiency is to be stated with regard to the working condition (compare §§ 4, 5, 6). If the efficiency is stated without reference to load then it shall be deemed to refer to normal load.

The power required for excitation or loss in the field rheostat is to be calculated as a loss when determining the efficiency.

§ 35. For generators, synchronous motors and transformers, the efficiency is to be stated on the supposition of equality of phase between current and pressure.

§ 36. When machines have separate exciters the efficiency of both machines must be given separately.

Methods for the Determination of Efficiency.

§ 37. *Direct Electrical Method.*—This method can be employed with motor-generators, converters and transformers by measuring electrically the power put in and given out. In order to employ similar measuring instruments, it is desirable in this method to test similar machines or transformers in pairs.

§ 38. *Indirect Electrical Method.*—If two similar machines are obtainable they are mechanically and electrically coupled so that one runs as generator and the other as motor. The system is driven by means of current from an external source in such a way that only the power required to cover the losses is supplied and measured. The arrangement is to be regulated so that the mean between the power given to the motor and given out to the generator is as nearly as possible the normal output of the single machine, this average value being determined by measurement. The power supplied to cover the losses can also be applied mechanically and measured electrically.

If belt gearing cannot be avoided in this measurement the losses occasioned by it are to be taken account of.

The method above described can also be employed with transformers if the latter are identical so far as output, pressure and frequency are concerned. The loss occurring in any auxiliary apparatus is to be taken account of.

§ 39. *The Direct Brake Method.*—This method is generally employed for small motors, but can also be employed for a small generator which is being driven as a motor, in which case the conditions must be so chosen that the magnetic and mechanical stresses, speed and output differ as little as possible from what they would be if the machine were used as a generator.

§ 40. *The Indirect Brake Method.*—If a generator or motor of corresponding output is obtainable whose efficiency at various loads is accurately known, this can be employed as a brake or as a driving motor. If a belt-drive is employed the loss in it must be taken account of.

§ 41. *No Load Method.*—This machine is run light as a motor and the loss at normal speed and field strength is determined. This

represents the losses due to air, bearing and brush friction, hysteresis and eddy currents whose variation with the load is not taken account of. By electrical measurements and calculations the C^2R loss in the field, armature, brushes and contact resistances at the corresponding load is determined when the machine is warm. In the case of asynchronous motors the losses in the secondary armature may be determined by measurements of slip instead of by measurements of resistance. The losses in regulating resistances in series with the field windings are to be taken account of. This method may also be applied for transformers.

The sum of the losses determined as above is called the "*measured loss.*" The efficiency is to be considered as the ratio of output to the sum of output and measured loss.

§ 42. *Auxiliary Motor Method.*—If there are difficulties in the way of direct determination of the friction losses as well as of the hysteresis and eddy currents, or if a suitable source of current cannot be obtained for driving the machine, the frictional, hysteresis and eddy current losses may be determined by means of an auxiliary motor. The machine to be tested is given its normal excitation, and the power required to drive the auxiliary motor is determined. The losses in the auxiliary motor (and if a belt-drive be employed the losses in this) are then deducted, having been obtained by measurements and calculations as in § 41. A steam engine can be employed in place of the auxiliary motor if it can be disconnected from the dynamo. In this case the steam engine is indicated when driving the generator at light load at normal speed and excitation, and then the steam engine is indicated again after the dynamo has been uncoupled. The difference between the two indicated horse-powers may be taken as the light-load losses of the generator. This method must be used with great care on account of the inaccuracy of light-load diagrams.

§ 43. *Indicator Method.*—If the generator is driven directly by a steam engine and cannot be uncoupled, the efficiency may be determined without regard to friction. The hysteresis and eddy current losses occurring at no load at the normal speed and pressure are determined by taking indicator diagram with the machine excited and not excited. If the excitation is provided from the same steam engine, the power required for it is to be subtracted. The difference is regarded as loss due to hysteresis and eddy currents, and no account is taken of its variation with load. By means of electrical measurements and calculations the ohmic loss in field, armature, and brushes is then determined. Account is to be taken of the fact that the contact resistance of the brushes varies with the speed and current density, and that the ohmic losses of the windings must be calculated for the working temperature. Losses occurring in normal working in field rheostats are to be included in the calculation. The sum of the losses as above determined is called the "*measured loss.*" The efficiency is to be considered as the ratio of output to the sum of output and measured loss. This method must be used with great care on account of the inaccuracy of light load diagrams.

§ 44. *Separation Method.*— For machines which have no bearings of their own the efficiency shall be determined without regard to friction in the following manner. The loss due to eddy currents and hysteresis is to be determined in similar manner as prescribed for the "no load method" by running the machine light as a motor. In order to separate the loss due to air, brush, and journal friction from the loss due to eddy currents and hysteresis, proceed as follows. The machine is to be run without load at different pressure but normal speed. It is advisable to reduce the pressure as far as possible after having taken readings at normal pressure, and if possible at 25 per cent. excess pressure. The readings are to be plotted graphically, and the curve prolonged backwards to the point of zero pressure. The corresponding value is the loss due to friction, and is to be deducted from the loss determined at normal pressure. The rest is to be considered as loss due to eddy currents and hysteresis, and no account is taken of its variation with load. The other losses are to be determined as in § 41. The sum of the losses due to eddy currents, hysteresis, resistance of field, armature and brush contacts, is called the *measured loss.* The efficiency is to be considered as the ratio of output to the sum of output and measured loss. The determination of the losses due to eddy currents and hysteresis can also be made by means of an auxiliary motor.

Change of Pressure.

§ 45. The change of pressure in alternators is to be stated for normal armature current when the load is non-inductive, and for one-third of normal armature current when the load is inductive with a power factor not exceeding 0·3.

§ 46. The change of pressure at non-inductive load is that variation of pressure which is observed on removing the full working load (power factor = 1) whilst not altering the speed and full load excitation.

§ 47. The change of pressure at inductive load is the variation of pressure which is observed if the armature current is switched off whilst speed and excitation remain unaltered. Before switching off, the machine must be loaded to a third of normal armature current, the power factor not exceeding 0·3, and the excitation must be such as to produce at that load normal terminal pressure.

§ 48. Machines for inductionless load need not be tested as described in § 47, and machines for inductive load need not be tested as described in § 46.

§ 49. If continuous current machines are to be tested for variations in pressure, the following is to be observed:—Continuous current machines with shunt, compound, or separate excitation, are tested at four different approximately equi-distant loads from full load at normal pressure to no load, without the excitation being adjusted. The difference between the greatest and smallest observed pressure is to be taken as the pressure variation. As regards the position of brushes during this test, the same practice as agreed on for ordinary working shall be adhered to.

§ 50. For transformers the ohmic loss of pressure and the short-circuit pressure with the normal secondary current has to be given, both for the secondary circuit. The ohmic loss is taken to be the pressure variation for inductionless load, the short-circuit pressure as the pressure variation for inductive load. It is permissible to make the test with a current differing slightly from the normal, in which cases the variations in pressure must be calculated proportionately for normal current.

Discussion.

Mr. Weekes dwelt on the importance of overload capacity, which, he thought, should be great, as overloads are always likely to occur.

Prof. Hooper said that in some cases a very long time is required for the temperature to rise to a maximum; he had known a case in which a large machine ran for two days continuously, and on the third day it had reached a dangerously high temperature, and had to be stopped, though on the second day it was not too hot.

Mr. Ed. C. de Segundo said that many consulting engineers did not draw up proper specifications, and thought that students should be instructed in this particular kind of work.

Mr. Michael Longridge pointed out that it was not always advisable to go by the rise of temperature above the surrounding air, and that there is a safe absolute temperature beyond which insulation should not be raised, irrespective of the difference of temperature between it and the surrounding air.

Mr. Kapp, in reply to the last speaker, said that the point had not been overlooked, and referred him to the appendix to the paper. He said that the temperatures given were a little higher than was previously thought to be desirable, but that they had been arrived at by experiments. In reply to Mr. Weekes, high overload capacity is not really required, as it would mean a larger machine than necessary, and therefore increased cost; it would also mean a continuously lower efficiency. In reply to Prof. Hooper, he said that the difficulty of specifying a long time for a temperature rise test was that it would seldom be conscientiously carried out, and that if a temperature-time curve was plotted and the curve was found to bend over and tend to get flatter, then one could judge as to when the final temperature would be reached. In reply to Mr. Segundo, he said that only good engineers should be called in to advise, and that they should be called in before the work was done, and not after there is a quarrel between a manufacturer and his customer.

NOTES FOR DISCUSSION ON ELECTRICAL POWER SUPPLY IN SHIPBUILDING YARDS AND MARINE ENGINE WORKS.

By Robert Robertson, B.Sc.

(Abstract of Paper read in Section IV.)

Works of this kind, like all others, differ in size, in arrangement, and in many other respects so much that each case must be taken and considered in detail by itself before any reliable conclusion can be arrived at as to the advantages in that particular instance.

The conditions ruling in a shipyard are so different from those in an engine works that it will be convenient to consider the two separately, and also to take the latter part first.

Engine Works.—The advantages claimed for electrical driving in marine engine works may be conveniently classified under three heads, viz.:—(1) Saving in cost of power; (2) Flexibility of the system; (3) Increased output.

1. In considering this subject, the saving in cost of power is too often looked upon as the only advantage to be gained, and the advantage is treated lightly because the whole cost of power in a work of this class only bears a very small proportion to the other cost of production. It must, however, be evident that if the advantages gained under the other heads are such as to result in substantial increase of output and diminished cost of production, they are of much greater importance than the saving in cost of power.

The saving to be effected in the cost of power may be considered under two heads: (1) The saving in power production; and (2) the saving in distribution.

By the adoption of a central power plant with boilers and engines grouped together upon a suitable site, it is possible to use with advantage all appliances for getting cheap power, and thereby effect considerable reduction in the amount of steam used per horse-power generated. This saving is placed by several authorities, who have investigated the subject, at from 30 to 50 per cent.

In order to appreciate the saving under the head of distribution, it is necessary to consider the circumstances in each case. Under the old system of driving, this loss consists of evaporation from steam pipes, losses in main shafts, belting, bevel gearings, &c.; and it is evident that these losses are practically constant at all loads, and bear a very much higher proportion to the total power when only partial load is on the plant.

In the case of the electrical system the distribution by means of wires or cables takes the place of the steam pipes, main shafts, main belts, bevel gearing, leaving in most cases only short lengths of straight shafts. The losses in the wires are such that they fall off in greater proportion than the load falls off, and therefore bear a more or less constant proportion to the power being used.

The saving to be effected by this means at full load will probably not exceed 5 or 10 per cent., but at all other times, when the load is other than the maximum, the saving will be much greater.

2. Under the second head of the advantages of this system of power—*i.e.*, flexibility—little need be said further than indicating the possibilities.

The use of separate motors for large tools, or for small groups of tools, enables these to be placed in the most suitable positions for convenient handling of the materials, irrespective of the position or direction of line shafts, &c. The advantages to be got by the extended use of portable tools, more especially in heavy work, is very great, the time and labour of shifting and setting the tools in many instances being very much less than if the heavy castings have themselves to be shifted frequently. The flexibility of the system is also of great advantage in the extension of works.

3. It is more difficult to appreciate the advantage of increased output, and it is by no means easy to demonstrate it, but there has been on various occasions when the subject has been discussed, considerable testimony by those who have adopted the system, that not only a very substantial increase of output is obtained, but also at a very considerable reduction of cost for labour. Among other causes for this improvement we have already seen the advantage of being able to place tools in the most convenient situations, and the possible large use of portable and semi-portable tools, several of which may be at work on the same piece of machinery simultaneously. The absence of a considerable amount of belting and shafting also admits of more extended and free use of overhead cranes, and such cranes are more speedily operated themselves by electric power. A further advantage is obtained from the fact that individual machines can more easily be driven at their most economical speed by electric driving.

Shipyards.—It is evident that all the advantages claimed in the case of engine works are greatly enhanced when the working of shipyards is considered. The same principles may be applied as in the other case, and it is unnecessary to consider them more in detail; but the advantages to be obtained by the flexibility of the system reach their maximum in a shipyard as compared with any other industry. The tools themselves are, as a rule, of a heavy class, which can most conveniently and economically be driven by independent motors, and may thus be disposed in such positions as to reduce to a minimum the handling of the raw material. With the increasing size of ships, and corresponding increase of weights of the component parts, this is of the greatest importance.

Further advantages may be obtained in a shipyard by the facility with which electricity may be applied to all forms of gantries, cranes, or other lifting appliances used in the erection of ships. Portable tools may be applied on board the ships during construction, and temporary workshops with semi-portable tools fitted up on board.

Equipment.—Here, also, it is only possible to deal with general principles. Broadly speaking, there are two systems which may be adopted, viz., the continuous current system, and the multiphase alternating current system. As regards the actual driving, either system is suitable for the shipbuilding industry, and each system has advantages peculiarly its own; the outstanding advantage in favour of the continuous current is the fact that motors of this class can more easily be adapted to run at varying speeds.

On the other hand, there are several advantages with multiphase current for work of this class. The starting arrangements are very simple, especially with small motors; the moving parts are of strong mechanical construction, and less liable to damage by overloading; and there are no brushes and commutators requiring attention. There is very little between the systems as regards cost and efficiency.

The question as to whether single motors on each machine tool, or group driving by means of short shafts should be adopted is of the greatest importance as regards economy in working. In the class of works under consideration there is, as a rule, not much difficulty in arriving at a decision. Unless in the case of special portable tools, it is not economical to employ motors of less than 5 H.P. Below this size the cost of motors per horse-power increases very rapidly and their efficiency decreases very rapidly, and in addition, where machines are worked intermittently and at varying powers, it is possible by suitable grouping to arrange a motor of, say, 10 or 20 H.P. upon a shaft to drive machines which, if supplied by separate motors, would require an aggregate of more than double that power. Single motors may be employed in the shipyard to greater advantage, but the tools in this case are of such a class that in very few cases will smaller motors than 5 H.P. be required.

It is impossible to consider the question of cost of installation in a general way, as it will vary in every case according to circumstances.

In conclusion, it may be confidently asserted that in the case of starting new engine shops and shipyards, it is undoubtedly the best policy to adopt electrical power, and that in most cases it will pay to make the change in existing works.

Vickerstown.—Mr. J. Newton Stephens, who has recently taken over the management of the Liverpool branch of the National Electric Wiring Company, Limited, has secured the contract for the electric lighting of Vickerstown, a second Port Sunlight. The houses are being built by Vickers, Sons & Maxim, Limited, Barrow-in-Furness, for the accommodation of their workmen, who number over 16,000. 500 houses are nearly completed, while others will be started shortly. Other large contracts recently obtained by him included the Barrow Co-operative Society's new premises (400 lights), Grand Hotel, Llandudno (800 lights, bells, telephones and ventilating fans) and the lighting of the isolation hospital at Crewe. Numerous smaller installations are also in hand.

THE CONVERSION OF SINGLE-PHASE PLANT TO MULTIPHASE.

By E. KILBURN SCOTT, A.M.I.C.E.

Owing to the increased employment of multiphase plant, those who are running single-phase central stations will find it necessary to consider how much of the plant they have already in use can be converted or utilised for two or three-phase working.

Alternators.—Taking alternators first, it is clear that those machines without iron in the armature, or copper machines as they are frequently called, such, for example, as Ferranti, Brush, and Siemens, cannot, under any circumstances, be altered to two or three-phase; on the other hand, those who have had the foresight to resist the specious arguments of interested scientific carpet baggers, and equip their central stations with ironclad alternators of the ordinary type, that is to say, stationary armature and revolving poles, will be able to have their machines converted quite readily.

In this connection it may be of interest to mention that some of the first single-phase machines to be converted were at the Clerkenwell station of the County of London Co., and the writer takes particular interest in them, as they were got out under his supervision whilst head draughtsman with the Electric Construction Company.

As originally constructed they had smooth core armatures, so that it was necessary to renew entirely the armature core plates to get the slots or tunnels which are necessary for multiphase winding. Of course, where an alternator has been originally built with slotted armature core, then the conversion to multiphase is the simplest thing in the world, as it only means winding a few extra coils through the empty tunnels. In this way the output of any single-phase machine can be considerably increased, because it should be remembered that every single-phase machine of the ordinary ironclad type is really a multiphase machine, having only a portion of the tunnels utilised.

Transformers.—Coming now to the transformers, the particular type originally introduced by Mr. Kapp appears to be the most favoured, and as in most other things, it has merely been a question of the survival of the fittest. Like the ironclad alternator, the Kapp transformer is a simple mechanical job, and by slight addition, it is capable of alteration to other conditions. It only needs another leg and another set of coils to convert it from single to three-phase, but by no conceivable alteration can the shell type of transformer, such as made by the British Electric Transformer Company, the Brush Company, the Electric Construction Company, the Westinghouse Company, and others, be altered to three-phase, and the one that is most hopeless appears to be the one most favoured by station engineers in this country at the present time, that is to say, the Berry transformer. It may be asked why should one have a transformer which can be converted into three-phase; cannot one have a separate transformer in each phase? The reply to this is, certainly you can, but it is a very great disadvantage, inasmuch as with a three-phase transformer any unbalancing is rectified by the fact that there is a common magnetic circuit to the three phases in each transformer. A particular instance in point occurred in the district of St. Etienne, in France, which is one of the first and one of the most interesting applications of three-phase alternating current for both power and lighting. The district is one where silk ribbon is made by a large number of small manufacturers, each owning one or two looms. The industry having become depressed, it was decided to put down a large central station, and to distribute three-phase alternating current to the various small manufacturers, so that their looms could be driven by power instead of by hand as previously. This was done, and the houses, &c., were also lighted by electricity. At the present moment there are about 3,000 small three-phase motors of about 1½ H.P. each, used for separately driving the ribbon looms. When the plant was first put down there were very few three-phase transformers on the market, and in order to use up the stock, the contractors laid down three separate transformers in every case, the result being that the switching on and off of motors upset the lighting terribly. On inquiry being made into the cause, it was found to be due to

the transformers, and the whole thing was cured by simply taking out the separate single-phase transformers, and using throughout proper three-phase transformers.

Other points in favour of a properly built three-phase transformer are that for a given output it is much cheaper, and that it takes up much less space than three separate transformers.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

17,066. "Improvements in registering and pole changing mechanism for electric meters and other electrical apparatus." R. Kennedy. August 26th.

17,070. "Improvements in or connected with incandescent electric lamps." A. L. Reinmann. August 26th.

17,088. "Improvements in dynamo-electric machines." M. W. W. Mackie and E. J. Glyn. August 26th.

17,132. "Improvements in the construction of insulators for electrically-separating sections of overhead trolley line and the like." R. C. Quin. August 27th.

17,139. "Improvements to safety life guards for electric trams or other motor-driven vehicles with means for automatically stopping the vehicle on coming in contact with any impediment." S. Dean and A. J. Instone. August 27th.

17,193. "Improvements in electric switches or circuit-breakers." The British Thomson-Houston Company, Limited. (E. M. Hewlett, United States.) August 27th. (Complete.)

17,194. "Improvements in electric arc light electrodes." The British Thomson-Houston Company, Limited. (R. H. Read, United States.) August 27th. (Complete.)

17,215. "Improvements in the construction of insulators for supporting overhead trolley lines and the like." R. C. Quin and J. F. Simpson. August 28th.

17,216. "Improvements in trolley heads for electrically propelled vehicles." S. J. C. D'Aintree. August 28th.

17,233. "Improvements in apparatus for testing insulation of electric cables." E. A. Claremont. August 28th.

17,249. "Improvements in magneto-electric machines." F. R. Simms and R. Bosch. August 28th. (Complete.)

17,256. "An improvement in the connecting of electrically-propelled cars." Siemens Bros. & Co., Limited, and A. Siemens. August 28th.

17,277. "Improvements in or relating to apparatus for quickly referring to the dimensions, weight, cost, electrical capacity, or other suitable data of electric storage batteries and the like." M. Sutherland and E. Marcueon. August 29th.

17,282. "Improvements in incandescent electric lamps of the Nernst type." B. M. Drake, G. S. Ram, and The Nernst Electric Light, Limited. August 29th.

17,285. "Improvements in electric burglar proof cases." G. L. Hogan. August 29th.

17,338. "Improvements in telephone systems." I. H. Parsons, of the firm of Gent & Co. August 29th.

17,342. "Improvements in electric telephony." C. Adams-Randall. August 29th.

17,343. "Improvements in telephonic repeaters and relays and circuits connected therewith and therefor." C. Adams-Randall. August 29th.

17,344. "Improvements in aerial or wireless telephony." C. Adams-Randall. August 29th.

17,345. "Improvements in simultaneous electric telegraphy and telephony." C. Adams-Randall. August 29th.

17,346. "Improvements in electric telegraphy." C. Adams-Randall. August 29th.

17,348. "Improvements in and relating to plates for secondary batteries." E. B. Viles. August 29th.

17,349. "Improvements in or relating to electric locomotives operated by accumulator batteries." O. Bohm and R. Menckhoff. August 29th.

17,357. "Improvements in or relating to trolley arms for electrical conductors." S. A. Hunter. August 29th.

17,363. "A luminous press button for electric bells for indicating when the attendant is coming." C. Dauvey. August 29th.

17,367. "Protective safety appliances for roof passengers of overhead electric cars." J. S. Comrie. August 30th.

17,381. "Improvements in the electric lighting of railway carriages." E. O. Mawson and A. T. Mirza. August 30th.

17,383. "Improved safety devices for guard wires of trolley wires and other conductors." D. S. Munro. August 30th.

17,410. "Improvements in means for breaking inductive electric circuits." The British Thomson-Houston Company, Limited, and R. C. Clinker. August 30th.

17,416. "Improvements in connection with electric tramcars." J. Timon. August 30th.

17,425. "Improvements in circuit breaking apparatus for electrical circuits." The British Westinghouse Electric and Manufacturing Company, Limited. (L. B. Stillwell, United States.) August 30th.

17,480. "An improvement in aluminium electrolytic cells." Siemens Bros. and Co., Limited. (Siemens & Halske Actiengesellschaft, Germany). August 31st. (Complete.)

17482. "Improvements in apparatus for electrically lighting railway trains." A. B. Gill. August 31st.

17,489. "Improvements in armature windings for dynamo-electric machines." H. M. Hobart. August 31st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

24,085. "Improvements in terminals and connections for electric cables and like conductors." R. F. Hall. Dated December 4th, 1899. A plate, having a number of knuckles or bridges alternating with gaps, forms a socket or attachment into which the bared end of the conductor is inserted, and is there secured by hammering or pinching the bridges. The conductor may also be soldered. 2 claims.

24,116. "Improvements in electric accumulators." A. Perrin. Dated December 4th, 1899. The separators consist of perforated plates of celluloid or the like provided with longitudinal semi-circular bearings which bear against the electrode plates. The separator plate has a projecting portion which rests upon the bottom of the cell. 2 claims.

24,126. "Improvements in electric maximum demand indicators." A. Wright. Dated December 4th, 1899. A maximum demand indicator consists of a vessel containing liquid and of such form that, when it is tilted by a supporting-pulley, a core and a coil carrying the current, in opposition to a spring or by other equivalent means, liquid is transferred from the main part to another of the vessel, and cannot return when the vessel returns to its normal position. Either part of the vessel is provided with a scale to measure the amount transferred. The provisional specification describes apparatus having two cores in the current coil, one being repelled by the other to tilt the registering-vessel. 4 claims.

24,143. "Improvements in electric furnaces for making glass and other analogous substances." J. Luhne. Dated December 4th, 1899. Relates to a furnace for making glass or the like. The materials are fed by an elevator into an elongated hopper, having undulating sides of a refractory substance surrounded by a non-conductor in a casing, and containing a regulating-cover. The materials pass through two horizontal rows of arcs, formed between edges of a single square negative electrode and two rows of positive rods, situated in ridged conical openings, from which ashes fall externally. The electrodes are perforated to admit air or hydrogen. The fused product collects in a channel below the arcs, and flows through a lower channel into a tank, over a wall and through openings into an outer compartment, where it is accessible through an opening. The channel consists partly of refractory material kept incandescent by passage of electric current. 4 claims.

24,175. "Improvements in or relating to electrically-propelled motor cars." F. W. Dickinson. Dated December 5th, 1899. Relates to the mounting or supporting of the motors in electrically-propelled vehicles. The yoke or framework is designed to carry two motors with their shafts in line. The yoke is composed of bars to which are secured the field magnets and coils, a central cross-bar, two side cross-bars, and end bridges or brackets. The motor shafts are carried in bearings in the cross bars and drive through toothed gear short shafts mounted in bearings in the bridges and finished with side chain wheels. The yokes are attached to the vehicle body by suitable prolongations or by hangers. 2 claims.

24,184. "Improvements in or relating to electrically-propelled vehicles." F. J. Newman and J. Lodwinka. Dated December 5th, 1899. Electro-motors for propelling vehicles are placed in the wheel hubs. The field magnets are carried by the extensions of the fixed axle, and the armature is carried by a spindle which is mounted in bearings in the end of the axle and a cup screwed on to the extensions. The hollow hub, built up of several parts, runs on ball bearings, and has an internally toothed ring, by which the wheel is driven from a pinion on the armature shaft through the gearing mounted on a stud on the extension. A modified form is also described in which the armature is mounted to run on an extension of the fixed axle. 7 claims.

24,186. "Improvements in multiple blade starting switches." W. Fairweather. Dated December 5th, 1899. Relates to resistance switches in which the resistances are controlled by a number of independently operated knife switches. Means are provided so that the switches can only be closed in a desired order. 3 claims.

24,196. "Improvements in and relating to thermostatic electric switches or pushes." G. Harrison. Dated December 5th, 1899. Relates to a push button and thermal switch adapted for an alarm in incubators, conservatories, &c. 5 claims.

24,208. "Improvements in electrically-controlled locking mechanism for collecting and other boxes." F. Williams. Dated December 5th, 1899. Relates to a system of electrically-controlled locks, which is described as applied to postal collecting boxes, but is also applicable to other boxes. The electric control is such that none of the boxes can be opened until a certain electric connection has been made at the central office, and after such connection has been made, the collections can only be made in a certain order, the lock of each box being controlled by the opening and closing of the door or cover of the box immediately preceding it in the allotted order. The opening and closing of each box also sound an alarm bell and make a time record at the office. The alarm bell may also be used by the collector to send messages to the office by a pre-arranged code. 15 claims.

24,228. "Improvements in electric railways on a road contact system." S. E. Gunyon. (H. Privat.) Dated December 5th, 1899. Electric railways and tramways on a road contact system with electro-magnetic switches. The pivoted contacts are depressed by the collector and complete a circuit for a shunt current (which may be replaced by a current from the battery if required) through a coil to the return conductor. The armature lever is thereby attracted, and completes the circuit at mercury contacts between the main supply and the studs. Springs return the parts. 2 claims.

24,230. "An improved anode or other electrode for use in electrolysis and process of making same." J. L. Roberts. Dated December 5th, 1899. Anodes and other electrodes are formed of an intimate mixture of powdered carbon, such as anthracite coal, and glass placed in an iron pan, then heated in an electric or other furnace till the glass is liquid, and finally charged into a red-hot mould formed of the sides, ends, and loose bottom. The material is covered by a thin iron plate above which is placed a red-hot plunger. Surrounding this mould, but separated from it by a layer of asbestos, is a two-part mould connected by lugs and bolts. The whole is then placed upon the base plate of a hydraulic press, and the plunger forced down with the required pressure. The pressure is retained until the glass has solidified. The electrode is then removed from the mould, and the thin iron peeled off by force, or dissolved off by acid. 4 claims.

24,297. "Improvements in electric accumulators." J. B. Rolin and C. A. Rosler. Dated December 6th, 1899. The electrodes are made up of a frame in which are placed a number of helically-twisted strips of lead attached by one end to the frame, the other being left free for expansion. The strips may be arranged vertically, horizontally, or diagonally. Their thickness is reduced by compression so as to flatten the outsides of the helices, a hard granular substance such as sodium chloride being sprinkled over them in order to preserve the empty spaces between the spirals, the granular substances being subsequently dissolved out. The strips may, after being twisted, be wound on a cylinder which is subsequently withdrawn from them. 3 claims.

24,387. "Electric incandescent lamp." C. van Deventer. Dated December 7th, 1899. An incandescing body of magnesia, kaolin, or other refractory material, is provided externally with infusible connecting wires, and encloses a heating wire which may be coiled on a piece of clay pipe stem. The body may be mounted in an open or exhausted glass bulb. 5 claims.

24,431. "An electric demand indicator." J. Rensselaer. Dated December 8th, 1899. A demand indicator for use on a supply conductor is constructed so that whenever the current rises more than a definite amount above a previously registered indication, and then falls below such previous indication, the pointer advances one division of the scale. The indication at any time thus shows how many such rises have occurred, and that the last such rise has at least reached the current indicated. A power indicator may be constructed similarly. 7 claims.

24,438. "Improvements in coin-controlled electric motors, fan motors, or the like." British Thomson-Houston Company. Dated December 8th, 1899. Relates to apparatus in which the coin completes the circuit of an electro-magnet operating a switch for the supply of electricity. 16 claims.

24,473. "Improvements in electric accumulator plates." W. Majert. Dated December 8th, 1899. Relates to plates or grids which are provided with ribs, and consists in stiffening such plates by providing them with solid marginal walls at opposite ends, the walls being formed by causing the ribs to stop short of the ends. 1 claim.